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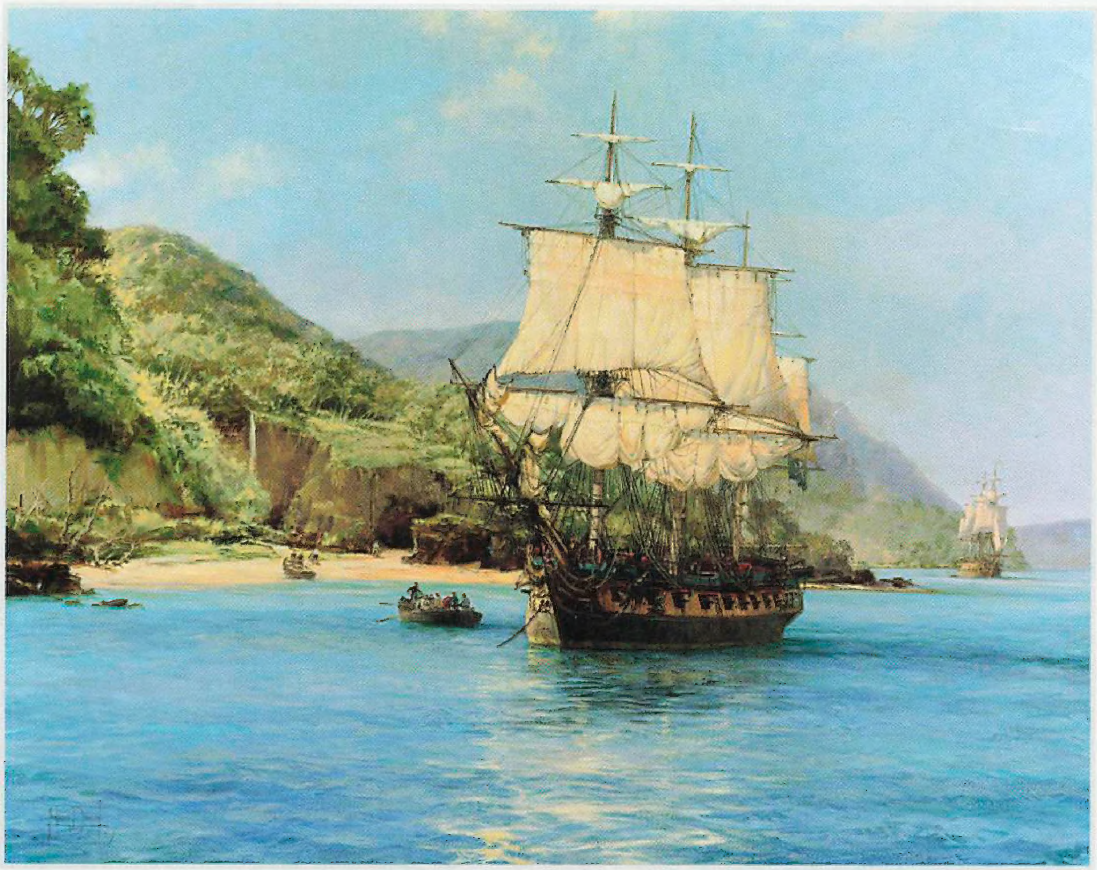

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The Pirate's Cove, Wafer Bay, Cocos Island
Artist: Montague Dawson (1895-1973)
Information: Date not given, oil on canvas, 40" x 50"

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See Williams, William Dampier (this issue)

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William Dampier

Science, Exploration, and Literary Influence, including his *Hydrographic Treatise* of 1699

By
Gary C. Williams

Editors Note

It is with great pleasure that we are able to present as the lead article in this issue of the Academy's *Proceedings* a biographical sketch of buccaneer/scientist William Dampier whose extraordinary contributions to late 18th century oceanography, natural history, and navigation, as well as to English literature are either overlooked or treated as secondary to what are preceived to be his more exciting exploits as a buccaneer. In this article, Dr. Gary Williams seeks to correct the imbalance and to place William Dampier firmly among the more notable of the late 18th century English naturalists and authors.

PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES

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William Dampier

Science, Exploration, and Literary Influence, Including his Hydrographic Treatise of 1699

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In a time when many people yearned for authentic first hand accounts of newly discovered regions of the world, few individuals succeeded as well as Captain William Dampier in providing such information. An English navigator of the late seventeenth and early eighteenth centuries, Dampier predated the exploits of James Cook by more than eighty years. He was also an accomplished naturalist and writer, his first book of travels and natural history appearing sixty-one years before publication of Linnaeus's Systema Naturae. He wrote about his observations at the Galápagos Islands, a century and a half before Darwin's visit.

His research endeavor was truly on a global scale, as Dampier made four major voyages, three of them round the world, mostly under very stressful and often dangerous circumstances. His keen interest, determination, and success regarding discovery and exploration are therefore remarkable. Dampier was an excellent navigator and mapmaker. He made major contributions to the exploration of Australia, New Guinea, and parts of Southeast Asia. In addition, he produced a seminal hydrographic treatise of the tropical oceans based on his personal observations, which represents a pioneering effort in the field of physical oceanography, precursory to the accomplishments of the Challenger expedition by more than one hundred and seventy years. Dampier's treatise, which has not received much attention from historians of science, is an important focus of the present paper.

Dampier periodically found it expedient to join buccaneering and privateering expeditions as a convenient mode of transport, and possibly as a means to help finance his research. The distinction of Dampier lies not in his reputation as a buccaneer, often overstated by some authors, but rather in the scientific and literary merits of his writing, which had a profound impact on eighteenth century English science and literature.

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Illustrations

PREFACE

One of the symptoms of an increasingly anti-intellectual societal trend, as is currently taking place in some industrial cultures such as the United States, is that people feel they have a need to search for simple answers to complex problems. An example is the need to create "big names" or a "hero culture" in many fields of endeavor (Berman 2000:55, 154, 158). In such a trend, big name individuals become virtually the sole focus of information as an information oligarchy is formed, which precludes the exposure of a greater diversity of views, opinions, and knowledge pools.

An example pertaining to the history of continental exploration is the Lewis and Clark expedition, which comes to the public perception as the big event in North American exploration, while the Freeman and Custis Red River Expedition of 1806 in the Spanish territory of the Louisiana Purchase, and also part of Thomas Jefferson's master plan for western exploration, has been relegated to near oblivion. This latter expedition produced a wealth of scientific information but was thwarted by the political maneuvering of Jefferson's rivals and the intercepting of the field party by the Spanish military. This situation of little recognition has been partially remedied by a recent work (Flores, 2002) on this southern expedition led by civilian scientists. Neither the northern or southern expeditions of Jefferson's exploration plan led to the discovery of a commercially viable water route to the Pacific, one of his expansionist goals.

Another example of this overshadowing by one event or persona over other significant contributors is the concentrated attention to Jefferson's northern expedition, while the enormous accomplishments of perhaps the greatest of North American explorers, Jedediah Smith, have been largely ignored except for the work of a few dedicated historians. Included here are Neihardt (1920), Sullivan (1934), Dale (1941), Farquhar (1943), Morgan (1953), Church and Chase (1976), Brooks (1977), and Carter (1982). Despite these contributions and the fact that the western historian William Goetzmann does much to direct attention to the accomplishments of Smith in his Pulitzer Prize winning book, *Exploration and Empire*, public perception remains much the same. Goetzmann (1966:141) summarizes the situation concerning Smith with Lewis and Clark:

> When Jedediah Smith died, much of his knowledge of the West died with him...this was an immense loss, for he had seen more of the West than any other man, and with a natural genius for geographic detail, greater even than that of Lewis and Clark, he had understood much of what he saw in geographic terms.
>
> Parochial views and nationalistic chauvinism have resulted in the glorification of the Lewis and Clark expedition at the expense of the largely ignored and equally important transcontinental Canadian expedition of 1793 by the Scottish born explorer, Alexander MacKenzie, thirteen years before Lewis and Clark reached the Pacific.

Concerning British maritime exploration, Captain James Cook (Grenfell Price 1971; Hedges, undated) has captured the accolades and primary recognition of historians. By contrast, the accomplishments and persona of Captain William Dampier (1651–1715) — the man who in a way set the stage for the explorations of James Cook, and who was significantly influential regarding eighteenth century English literature as well — has been for the most part underrated and misinterpreted. Only relatively recently has he gained more in-depth attention from historians, with fresh accounts of his explorations and accomplishments by authors such as Lloyd (1966) and, more recently, by Larson (2001) and Preston and Preston (2004). Overall, Dampier can be viewed as a truly unsung hero of early scientific exploration.

Introduction

Captain William Dampier (1652–1715) (Figs. 1, 2A) was an English navigator, explorer, naturalist, hydrographer, author, and buccaneer. His escapades with Caribbean pirates have provided subsequent authors with ample opportunities for sensationalist or misrepresentative writing, such as that of Burg (1983). His accomplishments are remarkable in light of the fact that his voyages were often plagued by desertions, mutinies, and a host of other disruptions or often life-threatening situations. The buccaneering aspects of Dampier's life are adequately covered in other works such as Wilkinson (1929), Lloyd (1966), Larson (2001), and Preston and Preston (2004). The details of his contributions and his adequacy as a naturalist are treated admirably by George (1999). I wish to stress here his science in a pre-scientific era — to emphasize the achievements and contributions of William Dampier the travel writer, Indo-Pacific explorer, and Pre-Linnean scientific observer, and to encompass a social and historical context with aspects of the eighteenth century English literature that he influenced.

By reading Dampier one gets the distinct impression that here is a man who is enamored by the pursuit of natural history and motivated by the thrill of discovery, a man who is not burdened by the appearance of metaphysics, which hindered some other naturalists or scientific writers, and who has not allowed such constraints to taint his open-mindedness and objectivity. Here is truly unassuming descriptive natural history and travel writing at its best. This was at a time when, from the Eurocentric perspective, virtually everything outside of Europe was considered new, exotic, and awaiting discovery. Referring to Dampier's third book, *A Voyage to New Holland* (Figs. 2B–C), Williamson (1939:xxv) observes:

> The chief interest of Dampier's book is not in the narrative of events, but in the descriptions of lands, seas and weather, of birds and beasts, fishes and plants, the whole range of natural phenomena which the author found so much more to his taste than the characters and actions of his fellow men.

Dampier can readily be included as part of that group of earlier naturalists, including Guillaume Rondelet (1507–1566), Konrad Gesner (1516–1565), and John Ray (1627–1705), that Louis Agassiz (1860:10) so warmly praised:

> It has been a source of constant delight for me, while perusing the works of the earlier naturalists, to sympathize with the genial spirit and the earnestness that pervade their writings, so free from egotism, and animosity against their fellow-students. Their devotion to their studies is equal to the spirit of reverence with which they look upon nature; and it is disgraceful to our age, that we must contrast with such dispositions the ill-will, the jealousies, the quarrels for priority, and the profanation, which pervade the discussions of certain modern authors. Moreover, in a systematic point of view, the great naturalists of the sixteenth century deserve to be studied more fully than they have been thus far. It is astonishing, for instance, to see how near Rondelet, in discussing views of Aristotle upon the affinities of animals, came to perceiving their true affinities, and their natural classification.

In addition, Gill (1997:10) states:

> he [Dampier] is also one of the very first explorers to be interested in discovery for its own sake — this is clear from the record of his first and most important long voyage round the world. A difficult man: a robber and a scientist; pirate and an explorer; a materialist and a visionary.

FIGURE 1. Portrait of Captain William Dampier by Thomas Murray (1663–1734), oil on canvas painted between 1697 and 1698 (by permission of the National Portrait Gallery, London).

Three of the best and most recent biographical works are those of Gill (1997) and Preston and Preston (2004) on the life of Dampier, and George (1999) who focuses on Dampier's natural history contributions. Earlier noteworthy biographies are Wilkinson (1929) on Dampier the explorer and adventurer, and Bonner (1934) who treats the literary merits of Dampier's writing and his influence on English literature.

A

B

A
VOYAGE
TO
NEW-HOLLAND, &c.
In the YEAR 1699.

Wherein are described,
The *Canary*-Islands, the Isles of *Mayo* and St. *Jago*. The Bay of *All-Saints*, with the Forts and Town of *Bahia* in *Brazil*. Cape *Salvadore*. The Winds on the *Brasilian* Coast. *Abrolhos* Shoals. A Table of all the *Variations* obserⱱ'd in this Voyage. Occurrences near the Cape of *Good-Hope*. The Course to *New-Holland*. *Shark's* Bay. The Isles and Coast, &c. of *New-Holland*.

Their Inhabitants, Manners, Customs, Trade, &c. Their Harbours, Soil, Beasts, Birds, Fish, &c. Trees, Plants, Fruits, &c.

Illustrated with several MAPS and DRAUGHTS: Also divers Birds, Fishes and Plants not found in this Part of the World, Curiously Ingraven on Copper-Plates.

VOL. III.

By Captain WILLIAM DAMPIER.

The THIRD EDITION.

LONDON,
Printed for JAMES *and* JOHN KNAPTON, at the *Crown* in St. *Paul's* Church-Yard. MDCCXXIX.

C

A
CONTINUATION
OF A
VOYAGE
TO
NEW-HOLLAND, &c.
In the YEAR 1699.

Wherein are described,
The Islands *Timor*, *Rotee* and *Anabao*. A Passage between the Islands *Timor* and *Anabao*. *Copang* and *Lapbao* Bays. The Islands *Omba*, *Fetter*, *Bande* and *Bird*. A Description of the Coast of *New-Guinea*. The Islands *Pulo Sabuda*, *Cockle*, King *William's*, *Providence*, *Garret Dennis*, *Ant. Cave's* and St. *John's*. Also a new Passage between *N. Guinea* and *Nova Britannia*. The Islands *Ceram*, *Bonao*, *Bouro*, and several Islands before unknown. The Coast of *Java*, and Streights of *Sunda*. Author's Arrival at *Batavia*, *Cape of Good Hope*, St. *Helens*, *I. Ascension*, &c. Their Inhabitants, Customs, Trade, &c. Harbours, Soil, Birds, Fish, &c. Trees, Plants, Fruits, &c.

Illustrated with MAPS and DRAUGHTS: Also divers Birds, Fishes, &c. not found in this Part of the World, Ingraven on Eighteen Copper-Plates.

By Captain WILLIAM DAMPIER.

LONDON,
Printed for JAMES *and* JOHN KNAPTON, at the *Crown* in St. *Paul's* Church-Yard. MDCCXXIX.

FIGURE 2. A. A posthumous portrait of William Dampier by William Charles Thomas Dobson (1817–1898), oil on canvas painted circa 1850; Rex Nan Kivell Collection NK5374 (by permission of the National Library of Australia, Canberra). B. Title page from *A Voyage to New Holland*, 1703. C. Title page from *A Continuation of a Voyage to New Holland*, 1709.

Some remarks on the text of the present paper — I have, with rare exception, preserved the original spelling, punctuation, and style of 300 year old quotations, which often differ significantly from contemporary English. Also preserved without alteration, is Dampier's original text of his 1699 hydrographic treatise. The period in which Dampier published his writing predated by a few decades the works of lexicographer Samuel Johnson (1709–1784) and others, when the standardization of definitions and spelling were formally attempted in the form of dictionaries of the English language. Comments or additions in the text of the present work that are in bolded italics within brackets are mine. An abridged version of this work appears in different form in Williams (2004).

Early Life

(See also Appendix 1)

Virtually all that we know of the early life of William Dampier can be found in the first two pages of chapter one of "The Campeachy Voyages," which comprises part two of his second book, *Voyages and Discoveries*. Dampier was probably born in the first half of 1652 (although some authors report 1651 as the correct year of his birth). He was born in East Coker, near Yeovil, in Somerset, southwestern England. His father, a farmer, died in 1662 when William was around ten years of age, and his mother died a few years later in 1668. Dampier was first sent to Latin School, as his parents had in mind for him a commercial life, but after their deaths his guardians transferred him to another school to learn arithmetic and writing, which aptly prepared him for the future life of mariner and author. His inclination at a very early age was to see the world, and he found employment at age eighteen as a shipmaster's apprentice at Weymouth with a master of a ship that was soon bound for France and later to Newfoundland.

Dampier (1931:129–130) relates this event:

> In this Voyage I spent one *Summer*; but so pinched with the rigour of that cold Climate, that upon my return I was absolutely against going to those parts of the *World*, but went home again to my Friends. Yet going up a while after to *London*, the offer of a *warm Voyage* and a *long* one, both which I always desired, soon carried me to Sea again. For hearing of an outward-bound East India Man...I entered my self aboard, and was employed before the Mast, for which my two former *Voyages* had some way qualified me. [Dampier continues] We went directly for *Bantam* in the Isle of *Java*, and staying there about two Months, came home again in little more than a Year: touching at St. *Jago* of the *Cape Verd* Islands at our going out, and at *Ascension* in our return. In this *Voyage* I gained more Experience in Navigation, but kept no Journal.

Upon his return to England, the Second Dutch War had broken out, and Dampier soon volunteered to serve in the British Navy on board the *Royal Prince*, commanded by Sir Edward Sprague. Dampier became very ill and was sent to Harwich with other sick and wounded where he languished, and later to his brother's residence to recuperate. At the age of twenty-two, a neighbor, Colonel William Helyar, made an offer to Dampier to manage his plantation in Jamaica. Soon leaving this employment that did not suit him, he chose a job as a woodcutter in the Bay of Campeche. It was during this period (ca. 1675–1678) that he began keeping a journal. However, there is some indication that Dampier may have at least been making field notes as early as 1671 (Gill 1997:23). Suffice it to say, Dampier began recording his travel observations during his early to mid twenties. Descriptions of these earlier exploits, which took place prior to his first circumglobal voyage, are contained in *Voyages and Discoveries*, his second book. It was in the Caribbean, at the beginning of his twelve-year first voyage around the world, when Dampier began his associations with buccaneers, circa 1679, at the age of twenty-seven.

The few primary sources regarding Dampier's character and personality come from the letters and descriptions by his contemporaries. Gill (1997:237) provides examples:

> Charles Hatton wrote to his relative, Christopher, First Viscount Hatton, in May 1697, that 'I have discoursed with Dampier. He is a blunt fellow, but of better understanding than would be expected from one of his education.' [Less patronizing but similar in his assessment of the mariner was John Evelyn, whose diary entry for 6th August 1698 reads:] 'I dined with Mr Pepys, where was Captain Dampier, who had been a famous buccaneer, had brought hither the painted prince Job, and printed a relation of his very strange adventure, and his observations....He seemed a more modest man than one would imagine by relation of the crew he had assorted with.'

Explorer/Mariner (1679–1711)

Maritime Exploration

Even before the voyages of Christopher Columbus and Vasco da Gama, the motivation for European maritime exploration had reflected various competing national interests. These interests soon became synonymous with the rapid acquisition of wealth through trade and the exploitation of natural resources and native human populations. Presumably the first such people to succumb to extinction precipitated by European expansion (even before the Arawacks of the Carbibbean) were the Canary Island Guanches, who suffered at the hands of Spanish conquistadors, through war, slavery, and introduced diseases. The beginning of the demise of the Guanches marks the inception of modern European imperialism commencing some ninety years prior to Columbus's voyage of 1492 (Crosby 1986).

Scientific exploration and discovery were never the primary or sole motivations for maritime exploration, but rather rode on the coattails of, or served as a source of new information for, commercial or national expansion interests. Gill (1997:10, 11) explains:

> Exploration was inspired by military and economic considerations: war and trade. All Europe knew of the vast possessions Spain laid claim to in America, and all Europe knew how ill-equipped Spain was to protect them. The mounting of major military expeditions at such a great distance was beyond the powers of Europe, however, and so for centuries a series of small depredations was made, often freelance, by English, French and Dutch traders and pirates; while at home the same nations and Spain participated...in a series of wars...Because his descriptions were so detailed, the knowledge he was sharing was also of great mercantile and military use, and there is no doubt that Dampier, and all his colleagues and contemporaries, had these applications in mind when they collected their information.

Even the early Mediterranean explorers – the Phoenicians, Carthaginians, and Greeks — had commercial motivations (Herdman 1923:2). After returning home from his fourth and last voyage in 1711, Dampier retired from a seaman's life at the age of sixty, on the earnings from his three books — albeit perhaps modestly. The vivid accounts of his published travels and the marvels he described sparked interest in his countrymen regarding the commercial potential of the South Seas region, and certainly stimulated incentive for subsequent voyages, such as those by James Cook six decades later. Dampier died in 1715, just four years after his return home.

The Four Voyages of William Dampier

Dampier's first two voyages were documented by him in three books. His first two books, *A*

New Voyage Round the World (1967) and *Voyages and Discoveries* (1699), covered various aspects of his first voyage, and the latter included his hydrographic treatise. His illustrated third book, *A Voyage to New Holland* (1703 and 1709), was published in two parts and served to document his second voyage. Dampier did not publish accounts of his third and fourth voyages, but several of his traveling colleagues did. Dampier's four voyages are detailed in the fine biography of Lloyd (1966); see also the review by Carver (2005).

First Voyage (1679–1691)

Dampier's first voyage resulted in a circumnavigation of the world that took twelve years, aboard several vessels with buccaneering intentions, and with long sojourns ashore at many locations. Important events include the marooning and later rescue of a Mosquito Indian named William on Juan Fernandez Island in the eastern Pacific, and exploration of the Galápagos Islands, the Philippines, and southeast Asia (Fig. 3). Dampier's careful journal notes formed the basis of his first book, a best seller at the time, *A New Voyage Round the World*, first published in 1697.

Second Voyage (1699–1701)

This voyage was the first official voyage of discovery ordered by the British Admiralty. Dampier with appointed as captain of the H.M.S. *Roebuck*. Preston and Preston (2004:255) discuss the significance of this voyage by stating:

> This was to be the Royal Navy's first expedition dedicated to both science and exploration — the direct forerunner of royal naval voyages from James Cook to James Clark Ross, Sir John Franklin, and Robert Falcon Scott.

The course of the voyage was from England via the Cape of Good Hope to Australia, New Guinea, and the Malay Archipelago, and return westward to Ascension Island where the *Roebuck* sank (Fig. 5). Dampier made an early collection of plants from western Australia, discovered New Britain, and wrote his second book from journal entries, *A Voyage to New Holland*. Dampier was court-martialed upon his return to England for cruel treatment of an officer and was relieved of ship's command in the British Navy.

Discovery of the wreck of H.M.S. *Roebuck*: In March of 2001, Dampier's ship from his second voyage, the H.M.S. *Roebuck*, was discovered and salvaged at Clarence Bay, Ascension Island (Figs. 4A–B, 5B), by an international team of wreck divers. Andrews and MacFall (2001:2) report the find. Andrews and Amalfi (2001:9) remark:

> *Roebuck* was a 290-ton, 26-gun ship built in 1690 by Edward Snellgrove of Wapping. It carried a complement of about 50 crew, including naval officers and provisions for about 20 months. Unfortunately, the British Admiralty, not thrilled at having to give a king's ship to Dampier who was a natural scientist, excellent navigator and ex-buccaneer, handed over to him a rotten ship that already was falling apart by the time he arrived at Ascension.

The SCUBA divers who discovered the wreck of the *Roebuck*, brought back two artifacts from the wreck site during their initial dives. These are the ship's bell, and one valve of a giant clam shell (probably *Tridacna gigas*). The clam shell was therefore presumably collected during Dampier's expedition in the Indo-Pacific, and subsequently lost before his return to England. Giant clams are

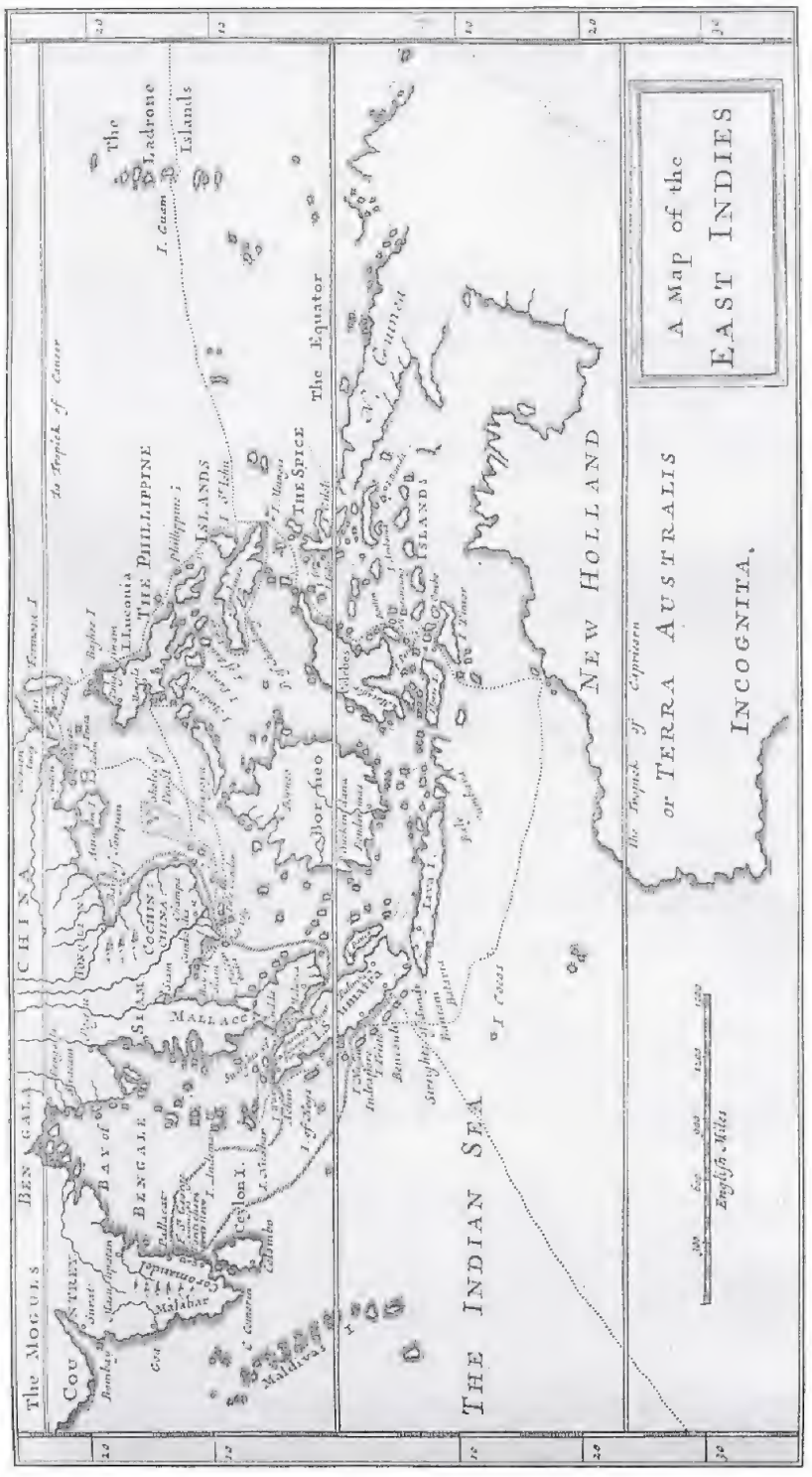

FIGURE 3. Dampier's map of the western Pacific and Indo-Malay regions, showing his travels between 1686 and 1691 (dotted line), during his first circumnavigation of the globe.

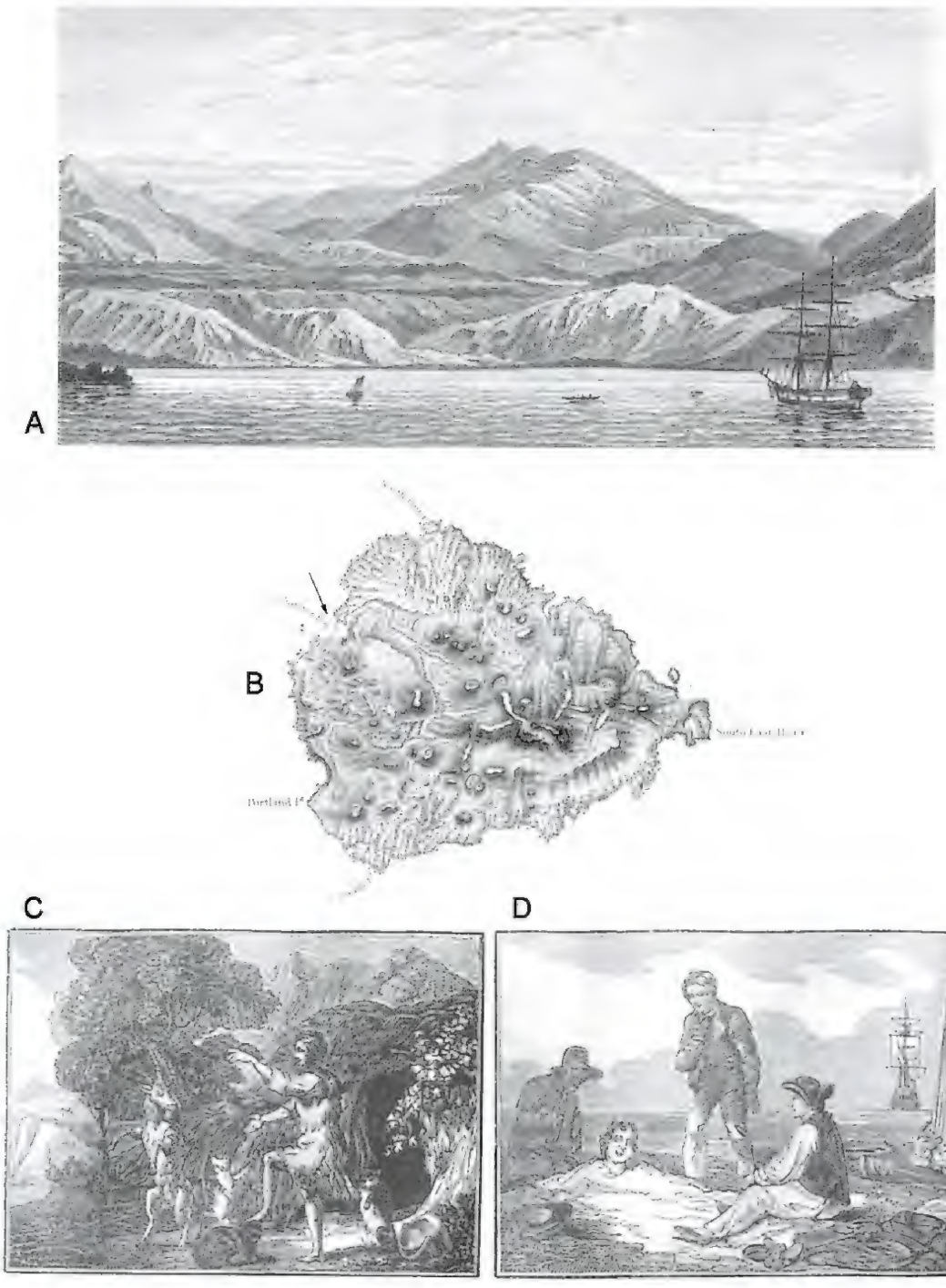

FIGURE 4. A-B. Clarence Bay, Ascension Island, South Atlantic, site of the sinking of Dampier's ship H.M.S. *Roebuck* on 25 February 1701; arrow shows location of Clarence Bay on the map in B. The wreck was discovered by divers 300 years later on 16 March 2001; both figures after Tizard, et al. 1885:927-929. C. "Selkirk amusing himself with Cats and Goats"; after Prior, 1844:106. D. "Dampier buried in the sand"; after Prior, 1844:74.

not indigenous to the Atlantic but are endemic to the Indo-Pacific. Andrews and Amalfi (2001: 10) continue:

> The artifacts were found in a highly exposed area of Clarence Bay, which acted as a trap for ships entering the bay. Dampier referred to having been shipwrecked on the northwest part of Ascension where his men were marooned for about five weeks before they were rescued. WA [Western Australian] author and shipwreck hunter Hugh Edwards said the clam was probably collected from WA's North-West where Dampier collected them before they were lost at Ascension. 'The clam was most likely collected from the Shark Bay area where Dampier also collected plants (Fig. 5A). There is a patch of this type of shell at Cape Inscription on Dirk Hartog Island.'

Third Voyage (1703–1707)

The third voyage was a difficult privateering venture is which Dampier captained the ship *St. George*. Dampier produced no published description of this circumnavigation of the world. However, an officer, William Funnell, published a book describing the voyage in 1707. Alexander Selkirk, a model for Defoe's Robinson Crusoe, was marooned on Juan Fernandez Island during this voyage (Fig. 4C).

Fourth Voyage (1708–1711)

Dampier's last voyage was another privateering circumnavigation of the world, but unlike the previous voyage was considered a highly profitable and successful venture. Dampier served as navigator under Captain Woodes Rogers. As with the third voyage, Dampier left no published account, but both Rogers and Edward Cooke produced publications in 1712 describing the voyage. Alexander Selkirk was rescued during this voyage and was brought safely home to English soil (Figs. 4C, 18A).

Woodes Rogers: Woodes Rogers was commander in chief of this daring and highly successful privateering expedition that captured and brought back to England, a Spanish 'Manila to Acapulco' Galleon worth an estimated £800,000 in treasure. Rogers was a gifted leader, extremely able at maintaining discipline, authority, and respect. His expedition was an exceptional exploit, comparable to that of Sir Francis Drake130 years before, and considerably more profitable. In fact, Drake and Rogers represent the first and last expeditions of an era, in which a prized Spanish Galleon was successfully taken by English pirates. The Roger's expedition was composed of two ships, the *Duke*, captained by Rogers, and the *Dutchess*, commanded by Captain Stephen Courtney with Edward Cooke as second captain.

Dampier was the expedition's pilot, as Rogers was well acquainted with his exceptional navigational skills, knowledge of tropical seas, and experience in plundering Spanish ships and settlements. Rogers was able to adroitly use Dampier's skills and knowledge to good advantage. Prior (1844:99) states, "the chief pilot was Captain William Dampier, whose name was sufficiently terrible to the Spaniards in the South Seas." Woodbury (1951:148) said of Rogers, "The very fact that he wrote a book about it, *A Cruising Voyage around the World*, which was and still is a classic of its kind and best-seller in its day, should have preserved his memory, but it hasn't...Historical neglect may be traceable, perhaps, to the fact that he was not of the nobility, was not and never became titled. His age was one where titles were oftentimes more important than the wearers." Perhaps Woodbury's reasoning can likewise help to explain the 'historical neglect' or under emphasis of Dampier's accomplishments.

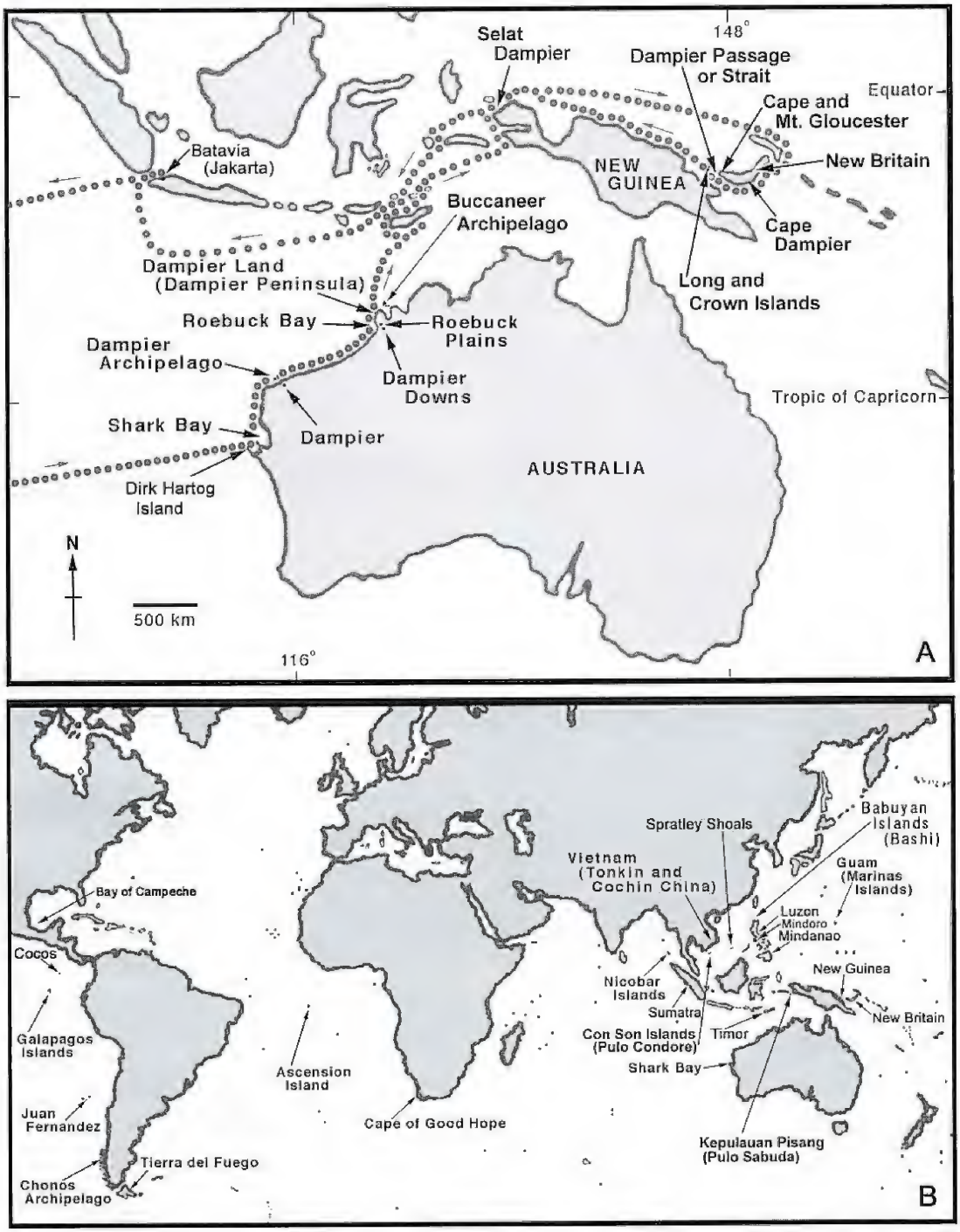

FIGURE 5. A. Map of the Austronesian region showing geographic features named for and by Dampier (arrows); and the 1699 route of the H.M.S. *Roebuck* during Dampier's second voyage of discovery (dots). B. World map showing noteworthy areas visited and described by Dampier during his four voyages.


A
B
C
D
E
F
G
H

Discoveries, Observations and Incidents

West Coast of the Americas

Between 1683 and 1686, Dampier acted as navigator during several privateering expeditions, which included the west coast of the Americas, between Tierra del Fuego (Fig. 6A) and Mexico, as well as the Juan Fernandez Islands, the Galápagos Islands (Fig. 6C), Cocos Island (Fig. 6D), and Tres Marias Islands off of central Mexico. He vividly describes the high Andes as seen from the Pacific (Fig. 6B), providing geographic information of a region virtually off limits to non-Spanish travelers during the period:

> All this course of the Land, both in *Chili* and *Peru* is vastly high…The Land…is of a most prodigious Heighth. It lies generally in Ridges parallel to the Shore, and 3 or 4 Ridges one with another, each surpassing other in heighth; and those that are farthest within Land, are much higher than others. They always appear blue when seen at Sea: sometimes they are obscured with Clouds, but not so often as the high Lands in other parts of the World, for here are seldom or never any Rains on these Hills, any more than in the Sea near it; neither are they subject to Fogs. These are the highest Mountains that ever I saw…by all likelihood these Ridges of Mountains do run in a continued Chain from one end of *Peru* and *Chili* to the other, all along this South-Sea Coast, called usually the *Andes*, or *Sierra Nuevada des Andes*. The excessive Height of these Mountains may possibly be the reason that there are no Rivers of note that fall into these Seas. [Dampier 1927:72].

In February of 1686, just prior to his departure on a trans-Pacific privateering voyage with Captain Swan on board the *Cygnet*, Dampier became seriously ill with edema. He describes the manner of his cure at Islas Marias, off the coast of Mexico between Mazatlán and Puerto Vallarta (Fig. 4D):

> I had been a long time sick of a Dropsy, a Distemper, whereof...many of our Men died; so here I was laid and covered all but my Head in the hot Sand: I endured it near half an Hour, and then was taken out and laid to sweat in a Tent. I did sweat exceedingly while I was in the Sand, and I do believe it did me much good, for I grew well soon after. [Dampier 1927:192]

Dampier provides some geopolitical insight as to the lack of concise geographic knowledge concerning California during the latter part of the seventeenth century:

> This Lake of *California* (for so the Sea, Channel or Streight, between that and the Continent, is called) is but little known to the *Spaniards*, by what I could ever learn; for their Drafts do not agree about it. Some of them do make *California* an Island, but give no manner of account of the Tides flowing in the Lake, or what depth of Water there is, or of the Harbours, Rivers, or Creeks, that border on it; Whereas on the West-side of the Island towards the *Asiatick* Coast, their Pilot-Book gives an account of the Coast from Cape St. *Lucas* to 40 d. North. Some of their Drafts newly made do make California to join to the Main. I do believe that the *Spaniards* do not care to have this Lake discovered,

FIGURE 6. Pacific islands and archipelagoes visited by Dampier, 1679-1711 (photographs by G.C. Williams). A. Tierra del Fuego, southern Argentina, 1993. B. The high Andes and islands off of Chile, 1980. C. Left: Sombrero Chino Island near James Island (Santiago), Galápagos Islands, Ecuador, 1994; right: Candelabra Cactus (*Jasminocereus thouarsii*) on Santa Cruz Island, Galápagos Islands, 1980. D. Cape Dampier, Cocos Island off Costa Rica, 2007. E. Ruins of a Spanish Fort, Guam, Marianas Islands, 1992. F. Southern Luzon with the mountains of Mindoro rising in the distant background, Philippines, 1997. G. Bagabag Island, north coast of Papua New Guinea, 1990 (referred to as "Sir Robert Rich's Island" by Dampier). H. The live volcano of Kar Kar Island (also known as Dampier Island), north coast of Papua New Guinea, 1990 (referred to as "Burning Isle" by Dampier).

> for fear lest other *European* Nations should get knowledge of it, and by that means visit the Mines of *New Mexico*. [Dampier 1927:189]

Dampier in the Indo-Pacific

During his four voyages, Dampier explored many regions of the vast Indian and Pacific Oceans (Figs. 3, 5, 7). Included here are parts of the west coast of the Americas, the Juan Fernandez Islands, the Galápagos Archipelago, Cocos Island, Guam, the Philippines, New Guinea, the Bismarck Archipelago, southeast Asia (particularly Vietnam), the Malay Archipelago, and the Nicobar Islands, as well as northwestern Australia. Geographic features named by or for Dampier in Western Australia include Shark Bay, Roebuck Bay, Dampier Land, and the Dampier Archipelago. Dampier's discoveries in Australia and their influence on subsequent British interest in the continent, have been amply treated by Pinkerton (1886), Tuckfield (1955), Copley (1966), Marchant (1988), and George (1999b). A memorial commemorating Dampier's landing on the Dampier Peninsula was erected during the Australian Bicentennial.

New Guinea

Dampier's map of 1701 (Fig. 7B), drawn from his original observations made along the north coast of New Guinea and the islands of the Bismarck Archipelago, was without a doubt the most accurate cartographic representation of that region published up to that time, and remained so until the eighteenth and nineteenth century explorations of Antoine de Bougainville, James Cook, Dumont D'Urville, and others.

Dampier's major geographic discoveries were made during his explorations of the coastlines of northwestern Australia, northern New Guinea, and the Bismarck Archipelago, as captain of H.M.S. *Roebuck* in 1699 and 1700. Geographic features discovered and named by or for him in the region include New Britain (he missed the strait between New Ireland and New Britain and therefore considered it as one island), Dampier's Passage separating New Britain from New Guinea, Long and Crown Islands near present-day Madang, Bagabag Island, which he named Sir Robert Rich's Island, and the live volcano of Kar Kar Island (also known as Dampier Island according to George, 1999:142), which Dampier referred to as Burning Island (Figs. 6G–H, 7B).

Excerpts from the written accounts of his discoveries in the Bismarck Archipelago, and along the northern coast of New Guinea near present day Madang are as follows:

> As we stood over to the Islands, we look'd out very well to the North, but could see no Land that way; by which I was well assur'd that we were got through, and that this East-Land does not join to *New-Guinea*; therefore I named it *Nova-Britannia*. The North-West Cape, I called Cape *Glocester*...and the North-West Mountain, which is very remarkable, I call'd Mount *Glocester*. This Island which I called *Nova-Britannia*...is generally high, mountainous Land, mixt with large Valleys; which, as well as the Mountains, appeared very fertile; and in most Places that we saw, the Trees are very large, tall and thick. It is also very well inhabited with strong well-limb'd *Negroes*, whom we found very daring and bold at several Places. [Dampier 1939:216]

The *Roebuck* was actually attacked by natives in canoes along this coast, now known as the separate island of New Ireland (Fig. 8).

> The 31st in the Forenoon we shot in between 2 Islands, lying about 4 Leagues asunder; with Intention to pass between them, The Southernmost is a long Island, with a high Hill at each End; this I named *Long Island*. The Northernmost is a round high Island towering

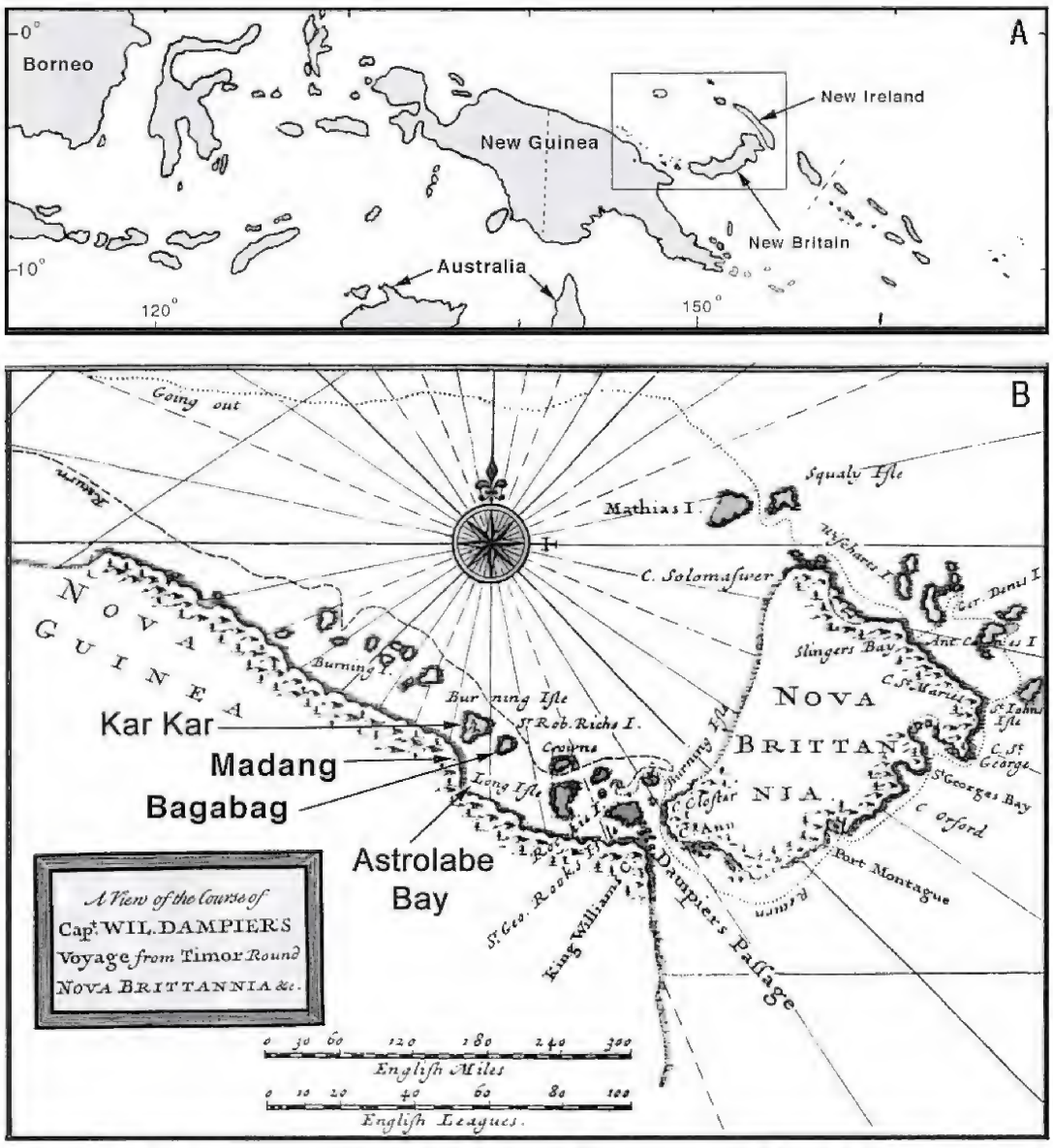

FIGURE 7. A. The equatorial western Pacific. Inset shows area of Dampier's map in B below. B. Dampier's 1701 map of northeastern New Guinea and New Britain; present day names shown in bold with arrows.

> up with several Heads or Tops, something resembling a Crown; this I named *Crown-Isle*, from its Form. Both these Islands appar'd very pleasant, having Spots of green Savannahs mixt among the Wood-land: The Trees appeared very green and flourishing, and some of them looked white and full of Blossoms. We past close by *Crown-Isle*; saw many Cocoa-nut Trees on the Bays and the Sides of the Hills; and one Boat was coming off from the Shore, but return'd again. [See: Fig. 7B]

Dampier continues:

> In the Afternoon, seeing an Island bearing North-West by West, we steer'd away North-

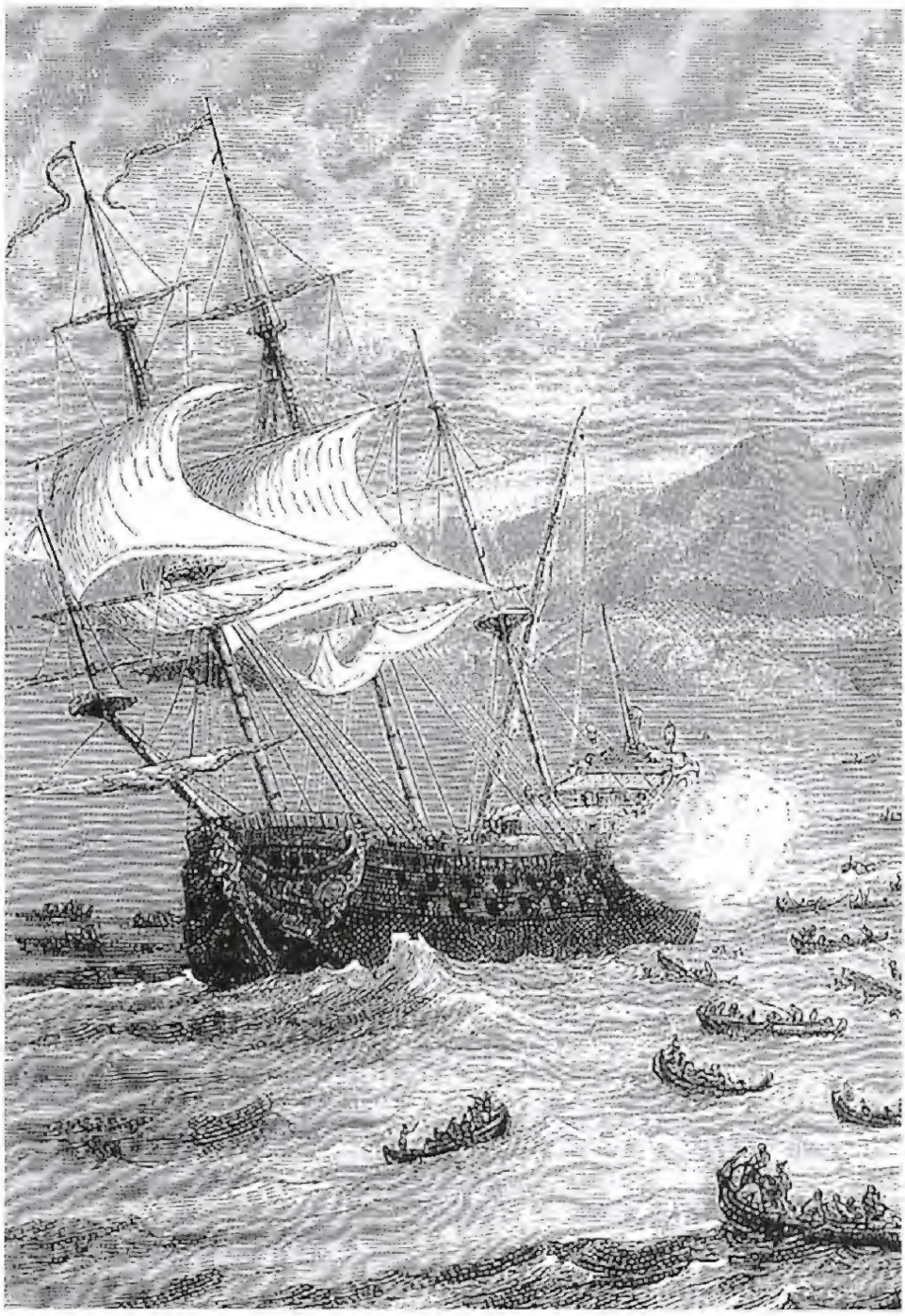

FIGURE 8. Dampier's ship, H.M.S. *Roebuck*, being attacked by New Irelanders, Bismarck Archipelago (by permission of the Mary Evans Picture Library, London).

> West by North...the Land of the Main of New Guinea within us to the Southward, appear'd very high....we kept on for the Island; which I named Sir R. Rich's Island [Bagabag Island, Fig. 6G; see also *National Geographic Atlas of the World*, 1990; map 100]. It was pretty high, woody, and mixt with Savannah's...On Tuesday the 2d of April, about 8 in the Morning, we discovered a high peeked Island to the Westward, which seem'd to smoak at its Top. The next Day we past by the North-side of the Burning Island [Kar Kar Island or Dampier Island, Fig. 6H; see *also National Geographic Atlas of the World*, 1990: map 100; and George, 1999:142], and saw a Smoak again at its Top; but the Vent lying on the South-side of the Peek, we could not observe it distinctly, nor see the Fire. [Dampier 1939:218]

As Dampier continued west along the north coast of New Guinea, he observed live volcanoes in this geologically volatile region (Fig. 9):

> We afterwards opened 3 more Islands, and some Land to the Southward...These Islands are all high, full of fair Trees and Spots of green Savannahs; as well the Burning Isle as the rest; but the Burning Isle was more round and peek'd at Top, very fine Land near the Sea, and for two Thirds up it. We also saw another Isle sending forth a great Smoak at once; but it soon vanished, and we saw it no more. We saw also among these Islands 3 small Vessels with Sails, which the People on *Nova Britannia* [Fig. 7B] seem wholly ignorant of [Dampier 1939:219].

The Philippines and Con Son Islands

Dampier spent a significant amount of time in the Philippines and provided detailed descriptions of the islands of Luzon (referred by him as "Luconia") (Figs. 3, 5B, 6F, 10A–B), Mindoro (Figs. 5B, 6F), and Mindanao (Fig. 5B). Among other things, he describes geography and topography of the islands, cultivated and edible plants, peoples and customs, domestic and wild animals, and aspects of the equatorial weather of the archipelago. His detailed description of edible fruits is an example:

> This Island [Mindanao] produceth also Durians and Jacks. The Trees that bear the Durians, are as big as Apple-Trees, full of Boughs. The Ring is thick and rough; the Fruit is so large that they grow only about the Bodies, or on the Limbs near the Body, like the Cacao. The Fruit is about the Bigness of a large Pumpkin, covered with a thick green rough Rind. When it is ripe, the Ring begins to turn yellow, but it is not fit to eat till it opens at the top. Then the Fruit in the inside is ripe, and sends forth an excellent Scent. When the Rind is opened, the Fruit may be split into four quarters; each quarter hath several small Cells, that inclose a certain quantity of the Fruit, according to the bigness of the Cell, for some are larger than others. [Dampier 1927:219]

He also explored remote and rarely visited localities in the Indo-Malay region including the Spratley Shoals or Spratly Islands (which he called the Pracel Shoals - not to be confused with the Paracel Islands, 600 km to the northwest) and the Con Son Islands (called by Dampier the "Pulo Condore" Islands) off of the Mekong River Delta (Figs. 5B, 10C). The Con Son Islands are part of Vietnam, while the Spratly's are at present simultaneously claimed by at least four nations: China, Malaysia, the Philippines, and Vietnam. Regarding these treacherous Shoals between Luzon and the Con Son Archipelago, Dampier (1697:264) relates:

> In our way thither we went pretty near the Shoals of *Pracel*, and other Shoals which are very dangerous. We were very much afraid of them, but escaped them without so much as seeing them, only at the very South-end of the *Pracel* Shoals we saw three little sandy islands or Spots of Sand standing just above Water within a Mile of us.

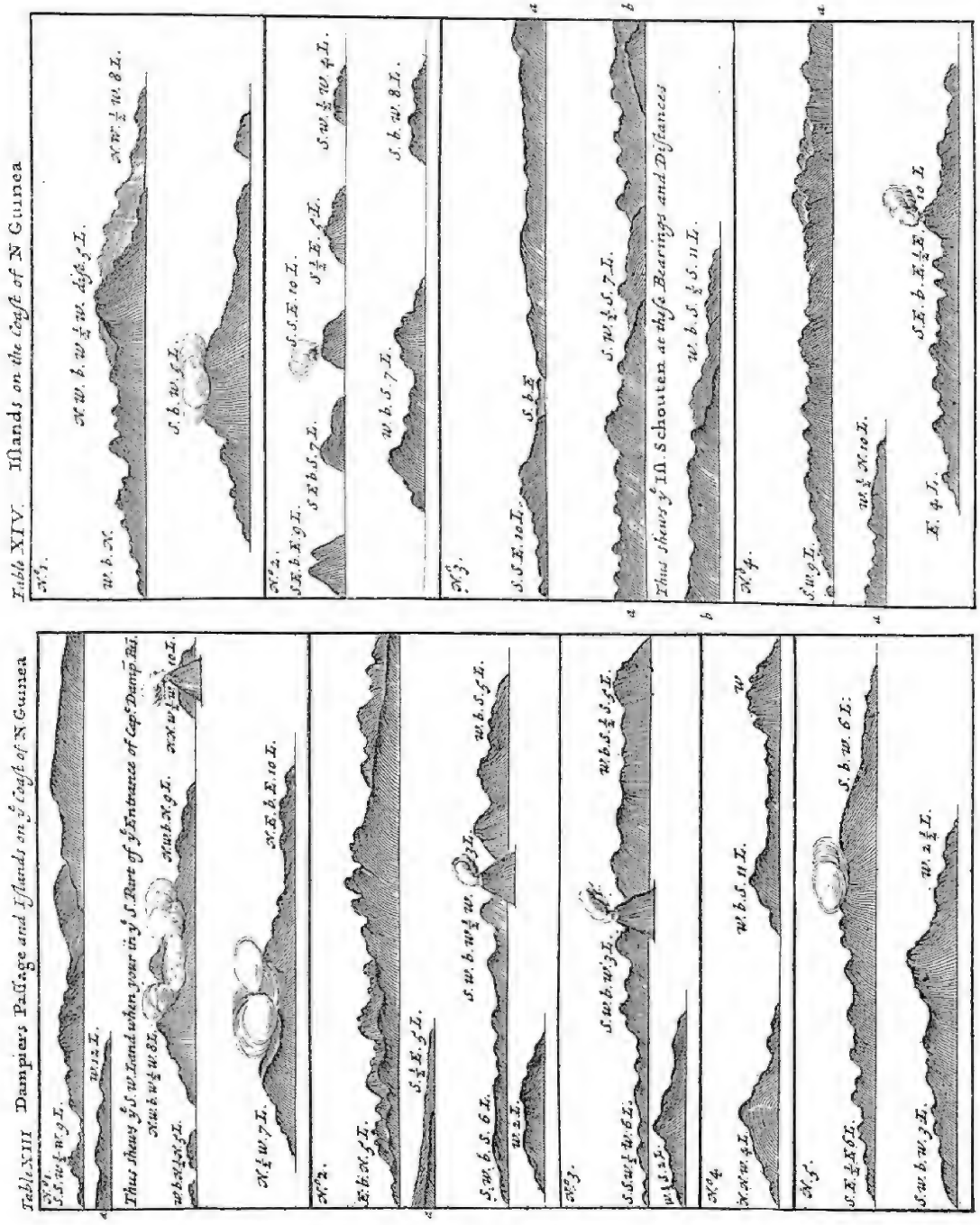

FIGURE. 9. Dampier's views of volcanic islands and the mainland of New Guinea; in the vicinity of Madang, north coast of Papua New Guinea; plates 13 and 14 from *A Voyage to New Holland.*

The accurate and often detailed geographic descriptions made by Dampier in his published accounts left a significant impression in the minds of the British Admiralty during the late seventeenth and early eighteenth centuries. A good example is a narrative by Dampier on the island of Luzon and Manila (Fig. 6F, 10A–B), from *A New Voyage Round the World*, composed from field notes made in 1687 (Dampier, 1927:260–263):

> This great Island hath abundance of small Keys or Islands lying about it...The Body of the Island *Luconia* [Luzon] is composed of many spacious plain Savannahs, and large Mountains...*Manila* the Chief, or perhaps the only City, lies at the Foot of a Ridge of high Hills, facing upon a spacious Harbour near the S.W. Point of the Island...It is environ'd with a high strong Wall, and very well fortify'd with Forts and Breast-works. The Houses are large, strongly built, and covered with Pan-tile. The Streets are large and pretty regular; with a Parade in the midst, after the *Spanish* Fashion...The Harbour is so large, that some Hundreds of Ships may ride here.

The Nicobar Islands

The articulate and eloquent nature of Dampier's writing is best observed when he describes deeply felt incidents of his life, those full of emotion and personal reflection. Perhaps no better example of this can be found in his account of a hazardous crossing between Nicobar and Sumatra (Fig. 5B) in a small open boat, a "Nicobar Canoa," voluntarily leaving a rebellious crew during a great monsoonal storm (Fig. 11A), which is contained in *A New Voyage Round the World* (Fig. 11B).

> It was the 15th Day of May 1688, about four a Clock in the Afternoon, when we left Nicobar Island, directing our Course towards Achin, being eight Men of us in Company, viz. three English, four Malayans, who were born at Achin, and the mungrel Portuguese...The Evening of this 18th Day was very dismal. The Sky look'd very black, being covered with dark Clouds, the Wind blew hard, and the Seas ran high. The Sea was already roaring in a white Foam about us; a dark Night coming on, and no Land in sight to shelter us, and our little Ark in danger to be swallowed by every Wave; and, what was worst of all, none of us thought our selves prepared for another World. The Reader may better guess than I can express, the Confusion that we were all in. I had been in many imminent Dangers before now, some of which I have already related, but the worst of them all was but a Play-game in comparison with this. I must confess that I was in great Conflicts of Mind at this time. Other Dangers came not upon me with such a leisurely and dreadful Solemnity. A sudden Skirmish or Engagement, or so, was nothing when one's Blood was up, and pushed forwards with eager Expectations. But here I had a lingring View of approaching Death, and little or no hopes of escaping it; and I must confess that my Courage, which I had hitherto kept up, failed me here; and I made very sad Reflections on my former Life, and looked back with Horrour and Detestation on Actions which before I disliked, but now I trembled at the remembrance of. I had long before this repented me of that roving Course of Life, but never with such Concern as now. I did also call to mind the many miraculous Acts of God's Providence towards me in the whole Course of my Life, of which kind I believe few Men have met with the like. [Dampier 1927:329, 332–333]

Naturalist

Dampier's second voyage was an official British voyage of exploration, and is the most important of his four voyages regarding his development and contributions as a natural historian. George (1999), in an in-depth and well-illustrated account, details Dampier the naturalist pertaining to botany, geography, and zoology. Also valuable is the detailed narrative of Preston and Preston (2004) concerning actual events of Dampier's natural history exploration and discoveries.

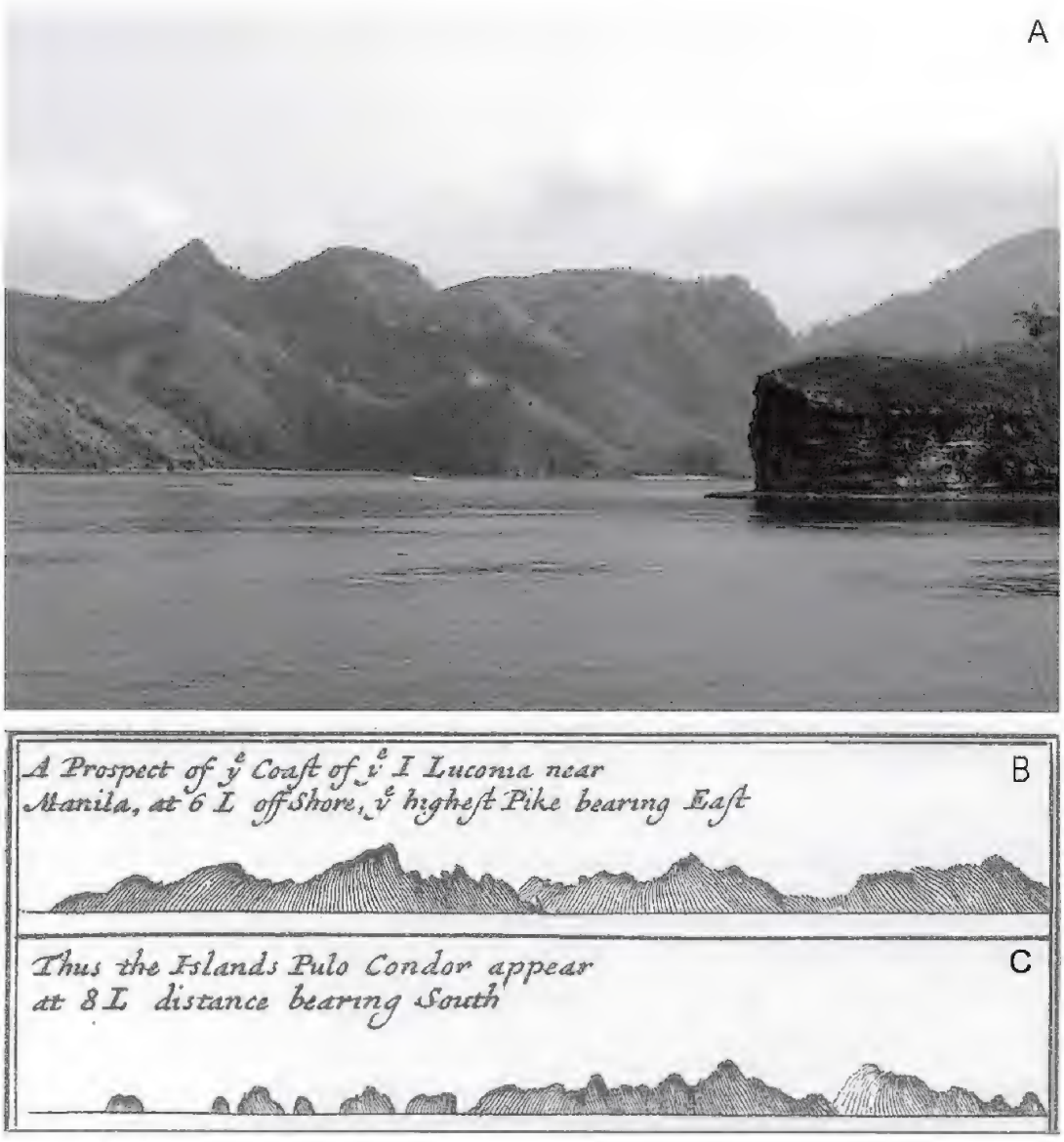

FIGURE 10. A. Southwestern Luzon just south of Manila Harbor, Philippines, 1995 (photograph by G.C. Williams). B. Dampier's view of the same region in 1687, 308 years earlier. C. Dampier's view of the Con Son Islands near the Mekong River Mouths, Vietnam.

FIGURE 11 (right). A. Dampier and his companions in their canoe overtaken by a dreadful (sic) storm; between Nicobar and Sumatra, eastern Indian Ocean; engraving; Rex Nan Kivell Collection NK 2188 (by permission of the National Library of Australia, Canberra). B. Title page from the first edition *A New Voyage Round the World*, 1697. C. Title page of Dampier's hydrographic treatise from the Argonaut Press edition of 1931; part 3 of *Voyages and Discoveries*, first published in 1699.

A

A

New Voyage

ROUND THE

WORLD.

Describing particularly,

The *Isthmus* of *America*, several Coasts and Islands in the *West Indies*, the Isles of *Cape Verd*, the Passage by *Terra del Fuego*, the *South Sea* Coasts of *Chili*, *Peru*, and *Mexico*; the Isle of *Guam* one of the *Ladrones*, *Mindanao*, and other *Philippine* and *East-India* Islands near *Cambodia*, *China*, *Formosa*, *Luconia*, *Celebes*, &c. *New Holland*, *Sumatra*, *Nicobar* Isles; the *Cape* of *Good Hope*, and *Santa Hellena*.

THEIR

Soil, Rivers, Harbours, Plants, Fruits, Animals, and Inhabitants.

THEIR

Customs, Religion, Government, Trade, *&c.*

By *William Dampier.*

Illustrated with Particular Maps and Draughts.

LONDON,

Printed for *James Knapton*, at the *Crown* in St *Paul's* Church-yard. M DC XCVII.

B

Cap. *Dampier*

HIS

DISCOURSE

OF THE

Trade-Winds, Breezes, Storms, Seasons of the Year, Tides and Currents of the TORRID ZONE throughout the World.

C

Prior to Dampier, the Dutch naturalist, Willem Piso (1511–1678) described aspects of the natural history of Brazil and India. His name is honored in the pantropical nyctaginaceous genus *Pisonia*, three species of which occur in Australia. In his brief reference to fishes in *Voyage to New Holland*, Dampier acknowledges the previous works of only two other naturalists — Francis Willughby (1635–1672), *Ichthyographia* (1685) and *Historia Piscium* (1686), and Piso. Since Dampier explored the eastern Indian Ocean, his reference to Piso likely refers to Piso (1658), which includes material on the natural history of India.

Dampier visited the Indian Ocean coast of Australia on two occasions, January 1688, and again from August to September of 1699. Prior to his landing in 1688, the Dutch voyager Francisco Pelsaert was shipwrecked on the islands of Houtman Abrolhos in June 1629. In January 1697, Willem de Vlamingh explored parts of the western coastline of Australia, exploring Rottnest Island and the Swan River, both near present-day Perth. Morley and Toelken (1983) report that perhaps the first Australian plant collection made by European collectors occurred during that cruise, and that two specimens still exist — probably from the Swan River region.

Dampier's pre-Linnean contributions to natural history are honored in the taxa named for him. Included here are the genera *Dampiera* (a genus of approximately sixty-six species of flowering plants endemic to Australia), *Willdampia* (the spectacular Sturt Pea or Sturt's Desert Pea, an Australian endemic). *Dampia* (an Indo-West Pacific soft coral genus originally described from the Dampier Archipelago, and *Dampierosa* (a genus of stonefish endemic to northwestern Australia) (Fig. 12 and Appendix 2).

Drawings of many natural history objects originally made by an assigned but unnamed artist on board H.M.S. *Roebuck*, appear in print in his third book, *A Voyage to New Holland*. These include mollusks, crustaceans, fish, seaweeds, flowering plants, birds, and bats (Figs. 12E, 13A, 14, 15, 16). No other illustrations of natural history objects, other than maps, appear in Dampier's other publications. But, for the second voyage, the commissioning of an artist was mandated by the written instructions of the Admiralty and only because the second voyage was officially authorized. Dampier's other voyages were privateering and were not officially sponsored by the government.

An interesting example of the many contributions to natural history by Dampier, is the first recorded observation of an Australian parrot, a kind of small white cockatoo known as the Little Corella (*Cacatua sanguinea*) on the 3rd of September 1699, when he landed at East Lewis Island in the Dampier Archipelago. He recorded the event in *A Voyage to New Holland*:

> We saw here some Cormorants, Gulls, Crabcatchers, &c. a few small Land Birds, and a sort of white Parrots, which flew a great many together (George 1999b:103).

These noisy birds move about in flocks and are common in northwestern Australia.

FIGURE 12 (right). Taxa named for William Dampier: A. Flowering plant, *Dampiera spicigera* Benth. (family Goodeniaceae), type locality - southwestern Western Australia (illustration by G.C. Williams; flowering branch approximately 150 mm in length). B. Dampier Stonefish, *Dampierosa daruma* Whitley, 1932 (family Scorpaenidae); type locality - Northwestern Australia; 13 cm maximum length (after Allen, 1997:77, by permission of the Western Australian Museum, Perth, Western Australia). C. Soft coral, *Dampia pocilloporaeformis* Alderslade, 1983 (Octocorallia: Alcyoniidae), type locality - Dampier Archipelago, Western Australia (photograph of 0.5 m long colony by G.C. Williams, Solomon Islands, 10 m depth, 1994). D. The Dampier Sea fan, *Pacifigorgia dampieri* Williams & Breedy, 2004 (Octocorallia: Gorgoniidae), endemic to the Galápagos Islands (photograph by G.C. Williams, 1994). E. Sturt Pea, *Swainsona* (formerly *Willdampia*) *formosa* (family Fabaceae); Dampier's black and white drawing of a plant he collected at East Lewis Island, Dampier Archipelago, Australia; after *A Voyage to New Holland* (1703) (coloration added by G.C. Williams; flowering branch approximately 100 mm in height).


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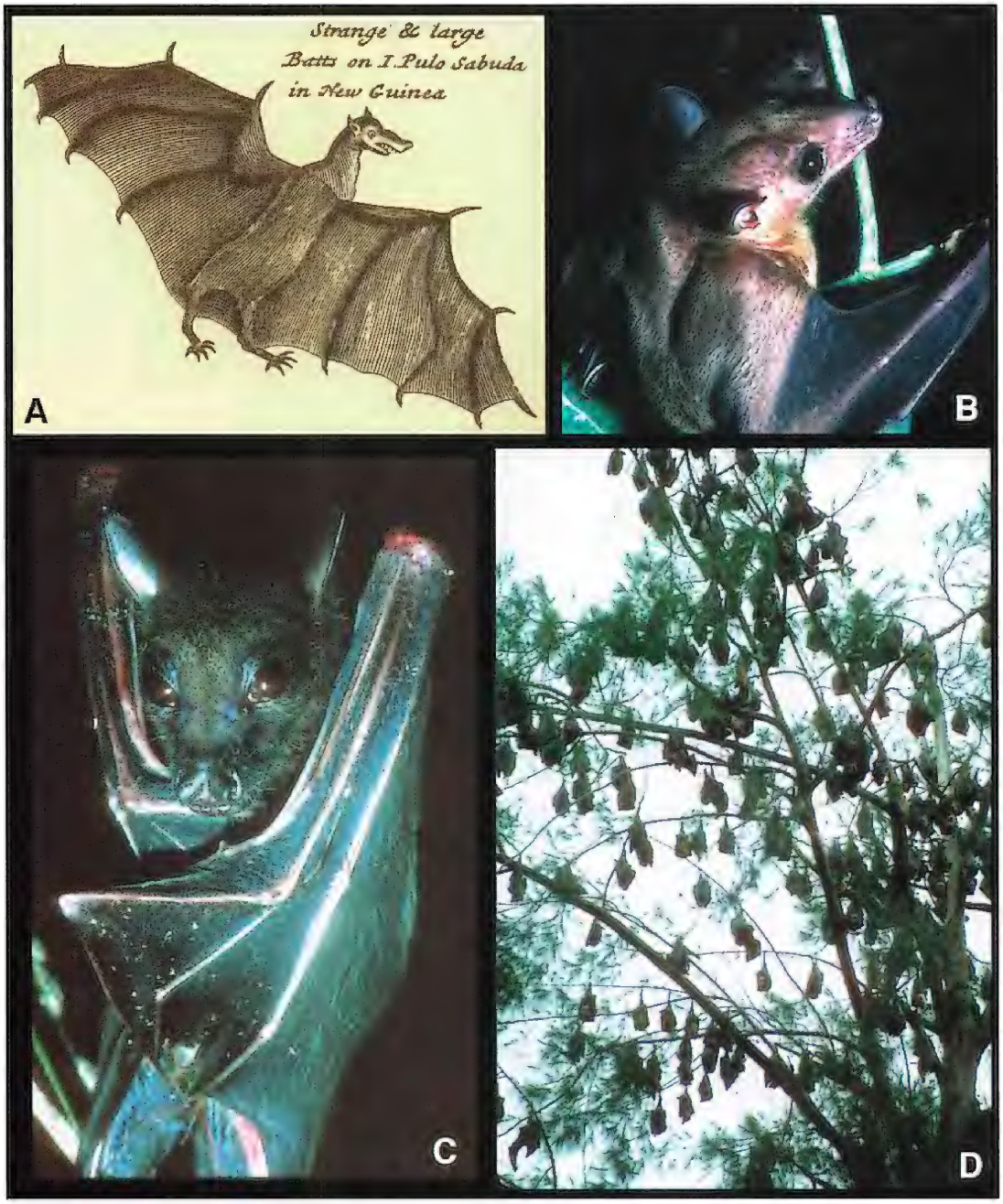


FIGURE 13. Flying foxes and other fruit bats (family Pteropodidae) of New Guinea. A. Dampier's drawing of a flying fox (*Pteropus* sp.) from Kepulauan Pisang (Pulo Sabuda of Dampier) in the Ceram Sea of Indonesia, just off the western tip of Irian Jaya. B. Lesser bare-backed fruit bat (*Dobsonia minor*), Madang region, Papua New Guinea. C. Rousette fruit bat (*Rousettus amplexicaudatus*), Madang region, Papua New Guinea. D. Roosting flying foxes (*Pteropus* sp.) in cassowary trees (*Casuarina* sp.), Madang, Papua New Guinea. (Photographs by G.C. Williams.)

Travel Writer

Dampier obviously had every intention of eventually publishing his field observations, and thus frequent journal entries and the protection of his field notes were of utmost importance to him during his travels.

He states in *Voyages and Discoveries* (which also contains his hydrographic treatise; see Fig. 11C):

> I took care before I left the Ship to provide myself a large Joint of Bambo, which I stopt at both Ends, closing it with Wax, so as to keep out any Water. In this I preserved my Journal and other Writings from being wet, tho' I was often forced to swim.

Several scholars are in agreement regarding the high quality of Dampier's writing. In his biographical sketch of Dampier, Gray (1927:xxxiii) remarks:

> His [Dampier's] whole time, so far as not interrupted by raids or the quarrels of his rowdy associates, was devoted to close observation of winds and tides, geography, plants and animal life. He was in fact a student carrying for the *nonce the fuzee* and hanger of a buccaneer. In happier days, and with a sounder scientific education, his status in a world cruise might have been that of Darwin on the *Beagle*.

In addition, Burney (1967: vol. 4) states:

> It is not easy to name another voyager or traveller who has given more useful information to the world; to whom the merchant and mariner are so much indebted; or who has communicated his information in a more unembarrassed and intelligible a manner. And this he has done in a style perfectly unassuming, equally free from affectation and from the most distant appearance of invention.

Finally, Gill (1997:232) comments:

> Dampier's work established a new, serious, analytical kind of travel writing, made readable by the brilliance of Dampier's style, which was often emulated. The Royal Society was impressed....

Dampier's first book of discovery, *A New Voyage Round the World* (Fig. 11B), is a classic of travel literature. Gray (1927:xiii) observes:

> In his Preface Dampier describes his book as 'composed of a mixt relation of places and actions,' a modest and inadequate indication which would hardly be approved by the advertising experts of the present day. The relation of places was, in fact, an extensive contribution to the geographical and ethnographical knowledge of his time. Nor does the description take count of the frequent excursions in the realm of natural history which diversify the main story with detailed accounts of tropical animals and plants....

In all of his writing, Dampier produced a charming, attractive prose that is a delight to read even some three centuries later. It was largely for this reason that his writing stands out among the many published accounts of travel writing produced during the age of maritime exploration. Wilkinson (1931:xiii, xxvi) states:

> Captain William Dampier, who thrice circumnavigated the globe..., won such success as came to him in his lifetime rather as a travel-writer than as a traveller. His works were "best-sellers" in the early eighteenth century, and they have delighted many thousands of readers ever since. They have almost every merit: an exceptional clarity and unaffected simplicity of style, combined with a kind of natural eloquence, and a power of eager, sym-

> pathetic, and accurate observation, amidst strange scenes and strange people, which was very rare indeed among travellers of that age....He attempted only to set down what he had seen and heard, and he did it in what seemed to him the easiest, shortest way, without ever dreaming that he was himself a natural stylist. His narrative flows like a smooth, unruffled stream; but we can distinguish it from any other stream. His manner is always the same, and is always unmistakable. It is almost and individual as Defoe's...In reading of his exploits in Tonquin, and especially his long overland journey, accompanied only by a native guide who knew no word of English, we must never forget that he was a sick man all the time, though he kept up his journal with unfailing regularity and never lost his interest in his surroundings. That, of course, is one of the secrets of his success as a travel-writer.

Along these lines, Kirkpatrick (1907–21:2) observes:

> [Dampier] writes with a curious gentleness and sympathy and in vigorous, dignified, expressive prose. A born wanderer and observer, he describes with quaint and picturesque fidelity seas, coasts, people, plants and animals. His observations on peoples, customs and trade have a distinct historical value.

The nature of this writing style and humor, intentional or not, is evident in the following passage from *A Voyage to New Holland*, where Dampier (1939:186) describes the inhabitants of islands in the Ceram Sea near the western tip of New Guinea:

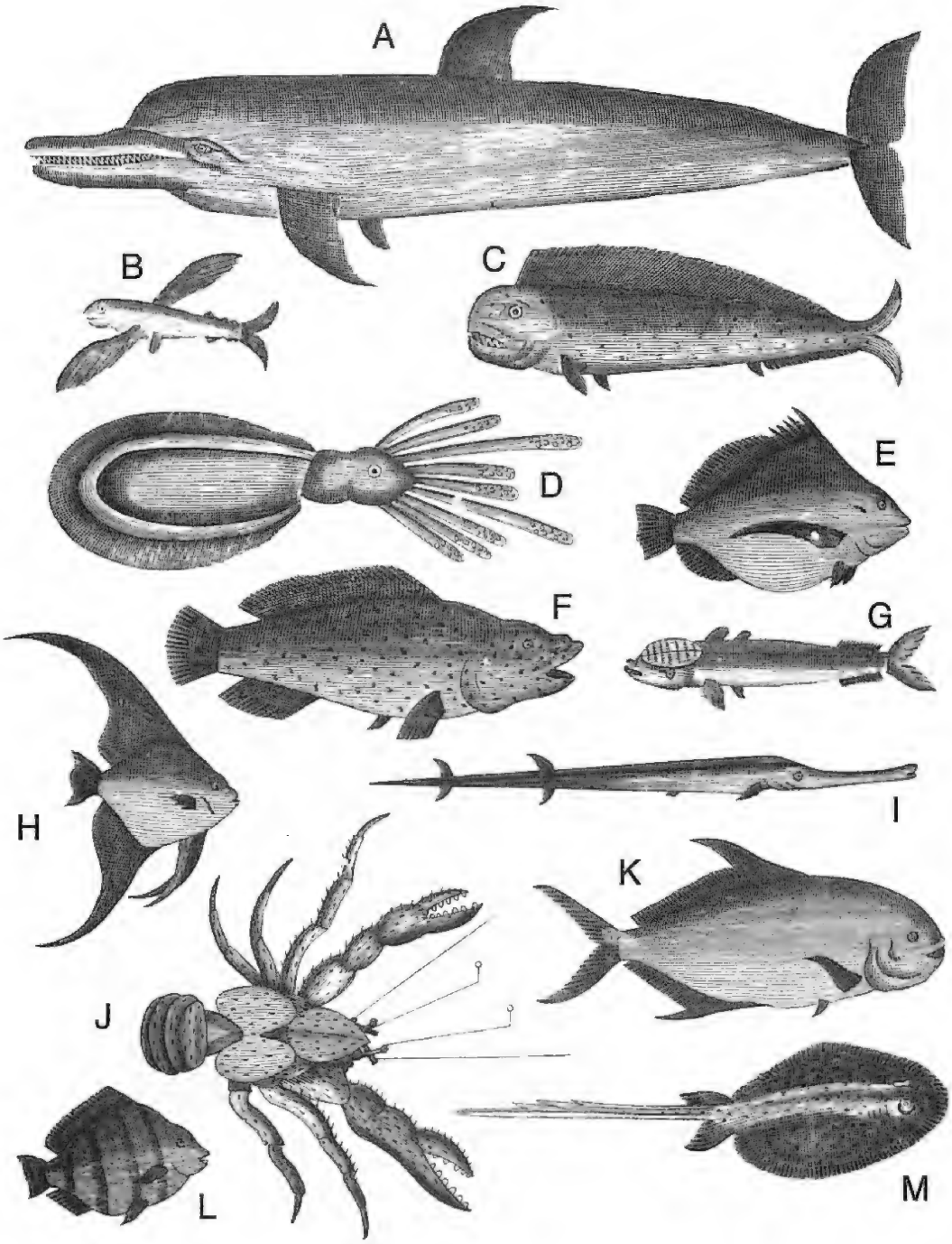
> I cannot tell of what Religion these [people] are: but I think they are not Mahometans, by their drinking Brandy out of the same Cup with us without any Scruple.

An example of Dampier's natural history writing is from his visit to a group of small islands just off the coast of western New Guinea in the Ceram Sea:

> This Island has no Name in our Draughts, but the Natives call it Pulo Sabuda [Fig. 5B, now known as Kepulauan Pisang; see: *National Geographic Atlas of the World*, 1990: map 80]. It is about 3 Leagues long, and 2 Miles wide, more or less...Here are likewise Abundance of Bats, as big as Coneys; their Necks, Head, ears and Noses, like Foxes; their Hair rough; that about their Necks, is of a whitish yellow, that on their Heads and Shoulders black; their Wings are 4 Foot over, from Tip to Tip: They smell like Foxes. [Dampier 1939:184–185]

At least fourteen species of flying foxes and fruit bats are known from northern New Guinea (Graham, 1991) (Fig. 13). It is not possible to identify this species confidently, because a specimen was presumably not taken during the voyage. In addtion, Dampier's description and the drawing executed by Dampier's on-board artist do not provide sufficient detail. Other animals and plants

FIGURE 14 (right). Examples of natural history drawings from *A Voyage to New Holland* — marine fauna. Dampier's original figure captions are in quotes as follows. A. "The Dolphin of the Antients taken near the line, called by our seamen a Porpus" (Bottlenose dolphin, *Tursiops truncatus*). B. "A Flying Fish taken in the open Sea" (Flyingfish, *Cypselurus* sp.). C. "A Dolphin as it is usually called by our seamen, taken in the open Sea" (Common dolphinfish, *Coryphaena hippurus*). D. "A Cuttle taken near N. Holland" (Cuttlefish, *Sepia* sp.). E. No caption other than "Fishes taken on the Coast of New Guinea." (possibly a Boarfish, *Pentaceros* sp.). F. No caption other than "Fishes taken on the Coast of New Guinea", (possibly a wrasse, family Labridae). G. "A Remora taken sticking to Sharks backs" (Remora, *Remora remora*). H. No caption other than "Fishes taken on the Coast of New Guinea." (a large juvenile batfish, *Platax* sp.). I. "A Pike Fish Conger on the Coast of New Guinea", (Flutemouth, *Fistularia* sp.). J. No caption other than "Fishes taken on the Coast of New Guinea", (Hermit crab, *Dardanus* sp.). K. No caption other than "Fishes taken on the Coast of New Guinea" (Pomfret, *Brama brama*). L. No caption other than "Fishes taken on the Coast of New Guinea." (possibly a sergeant major, *Abudefduf* sp.). M. "This Fish is a pale red with blew spots on the body the long Tail blew in the midle & white on the side" (Blue-spotted fantail stingray, *Taeniura lymma*).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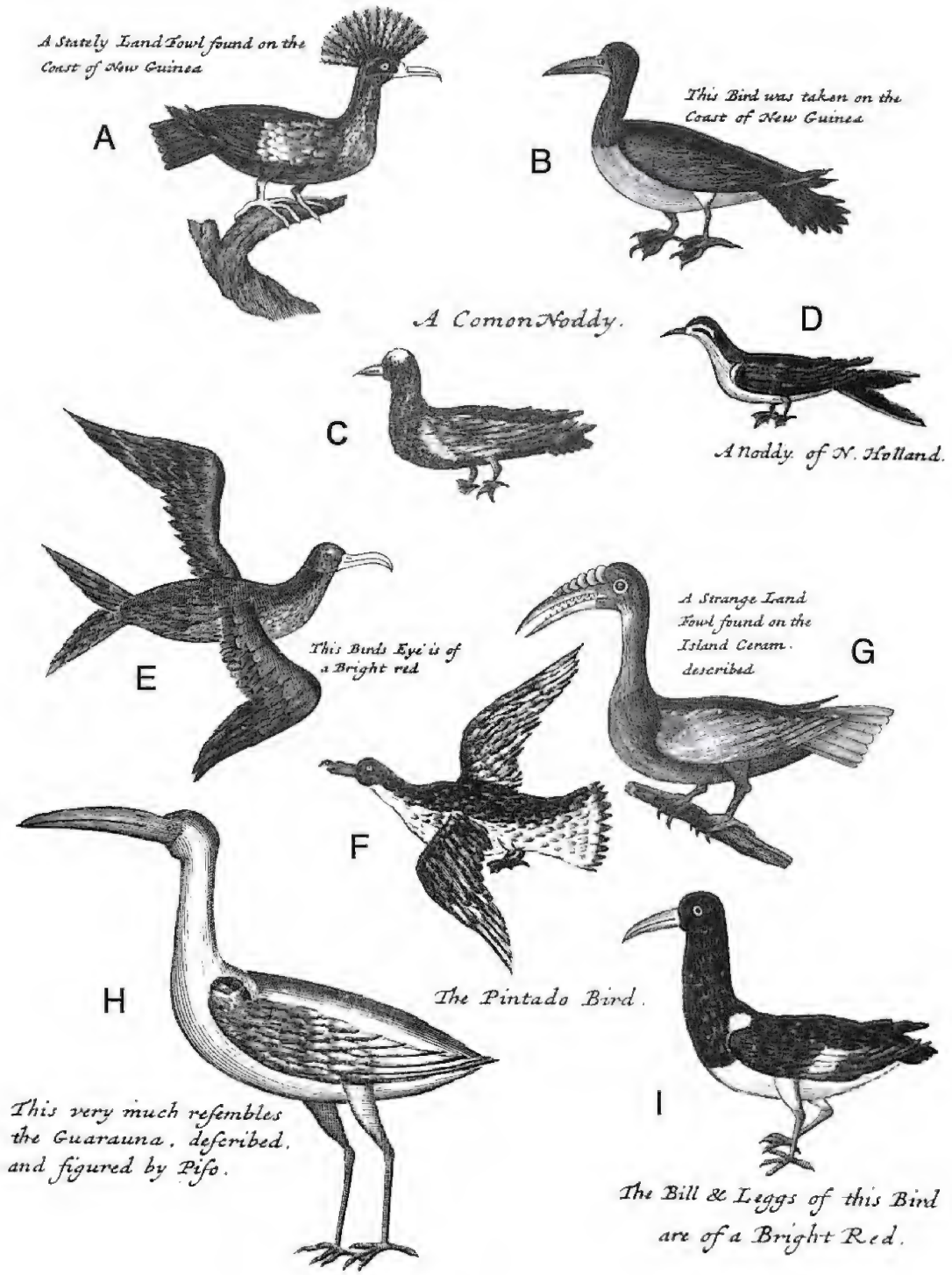
A Stately Land Fowl found on the Coast of New Guinea
A
This Bird was taken on the Coast of New Guinea
B
A Comon Noddy.
C
D
A Noddy of N. Holland.
E
This Birds Eye is of a Bright red
A Strange Land Fowl found on the Island Ceram. described
G
F
H
The Pintado Bird.
This very much resembles the Guarauna, described, and figured by Piso.
I
The Bill & Leggs of this Bird are of a Bright Red.

illustrated during the voyage and published in Voyage to New Holland can be identified with a greater degree of assurance (Figs. 12E, 14, 15, 16).

After Dampier's court martial in 1702 for mistreatment of an officer on board the H.M.S. *Roebuck*, he once again turned to piracy with two privateering voyages around the world. He apparently stopped keeping a journal, as we hear nothing more from him regarding publications or surviving journal entries up to the time of his death in 1715, except for his two part account of the H.M.S. *Roebuck* voyage (published in 1703 and 1709).

Plant Collector

"...he was...a pirate...who collected plants" (G. Seddon 1999)
"Pirates don't pick flowers" (R. Scott-Child 1992)

Dampier is best considered a plant collector and not a botanist. He was given the task of collecting Australian plants by the British Admiralty during his second expedition, the official British voyage of discovery on board H.M.S. *Roebuck*. Unlike botanists of his day, such as Michael Angelo Tilli (1655–1740), Leonard Plukenet (1641–1706), and John Ray (1627–1705), he did not conduct research in botany, name and describe new species of plants, or publish monographs. However, as a travel writer, he did describe and figure some of the Australasian plants that he encountered in *A Voyage to New Holland* (Fig. 16).

In 1699, Dampier made a collection of plant specimens at Dirk Hartog Island (Shark Bay) and East Lewis Island (Dampier Archipelago) on Australia's Indian Ocean coast (Fig. 3A). At least twenty-four of these, which Dampier managed to save when the *Roebuck* sank, have survived and are housed at England's Oxford Herbarium (George, 1999:27; Andrews and Amalfi 2001). The figure of twenty four specimens examined by A.S. George differs significantly from the unsubstantiated figure of "some 40 dried specimens" mentioned by Morley and Toelken (1983:13). The period of Dampier's two landfalls is contemporary with Dutch exploration of the Australian continent. Relative to all this, Morley and Toelken (1983:13) state:

> The first botanical collections from Australia were probably made in 1697 from the Swan River area of Western Australia, when a Dutch ship under the command of Vlamingh visited the area. Two dried specimens still exist from the expedition, and are thought to be the remains of this historic landfall....After this early Dutch visit to Western Australia, the next on which plants were collected was that of William Dampier (1652–1715), the English buccaneer, who visited the north-west of Western Australia in 1688 and again in 1699. In the latter year Dampier collected plants at Shark Bay and also on Dampier Archipelago, discovering *Clianthus formosus*, Sturt's desert pea. From this enterprise some forty dried specimens still exist.

In Dampier's account, *Voyage to New Holland* (1703), he describes these plants as English translations of the descriptions in Latin by Ray, which were published a year later. Dampier's 1703 volume also contains illustrations of these plants. Many of Dampier's plant specimens were also subsequently described and illustrated by the preeminent botanists John Ray (1704) and Leonard Plukenet (1705). Dampier was a competent plant collector. Seddon (1999:viii, ix) states:

FIGURE 15 (left). Examples of natural history drawings and captions from *A Voyage to New Holland* — birds. A. Victoria Crowned Pigeon (*Goura victoria*). B. Brown Booby (*Sula leucogaster*). C. Noddy (*Anous* sp.). D. Sooty Tern (*Sterna fuscata*). E. Great Frigatebird (*Fregata minor*). F. Pintado Petrel or Cape Pigeon (*Daption capense*). G. Blyth's Hornbill (*Rhyticeros plicatus*). H. Unidentified bird, possibly a heron (family Ardeidae). I. Pied Oystercatcher (*Haematopus longirostris*).

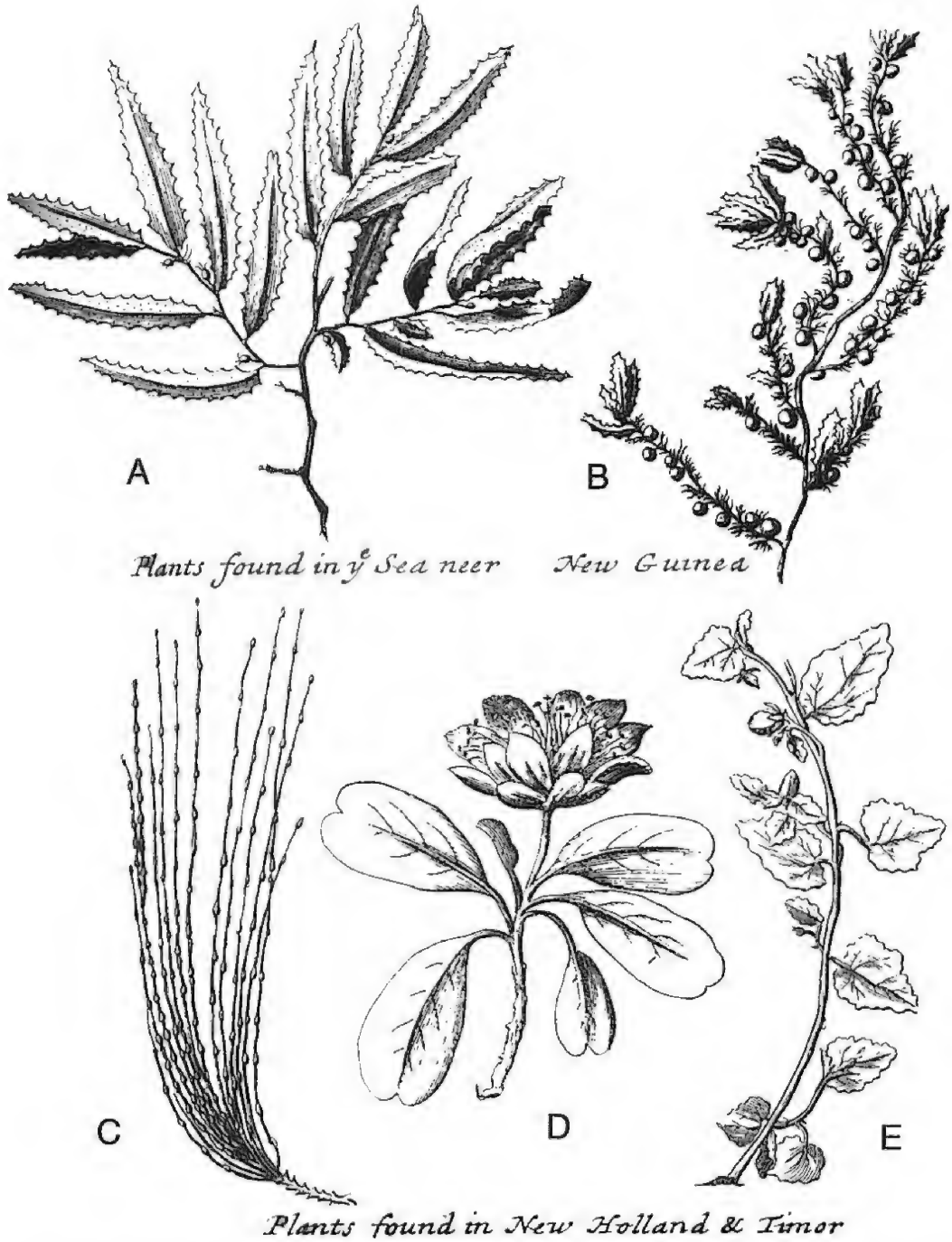

FIGURE 16. Examples of natural history drawings from *A Voyage to New Holland* — algae and plants. A. Seaweed, a brown alga (*Sargassum binderi*) collected by Dampier off New Guinea. B. Seaweed, a brown alga (*Sargassum ilicifolium*) from New Guinea. C. Red Beefwood (*Casuarina equisetifolia*), called "Whistling Pine" by Dampier and collected by him in Timor. D. Wild Rose (*Diplolaena grandiflora*, Rutaceae) from Shark Bay, Western Australia. E. *Hannafordia quadrivalvis*, Sterculiaceae, collected by Dampier at Shark Bay, Western Australia.

> he collected selectively, choosing those that he had not seen elsewhere....He pressed his specimens carefully and professionally: Alex George says that some of his specimens at Oxford are as well preserved as those collected recently.

Dampier (1703) describes a plant — also published in Latin by Ray (1704) — that he collected from Western Australia, later determined to belong to the family Rutaceae, and named by René Desfontaines (1817) as *Diplolaena grandiflora* (Fig.16D):

> Of what *Genus* this Shrub or Tree is, is uncertain, agreeing with none yet described, as far as can be judg'd by the State it is in. It has a very beautiful Flower, of a red Colour, as far as can be guess'd by the dry *Specimen*, consisting of 10 large *Petala*, hoary on both Sides, especially underneath; the Middle of the Flower is thick set with *Stamina*, which are woolly at the Bottom, the Length of the *Petala*, each of them crown'd with its *Apex*. The *Calix* is divided into 5 round pointed Parts. The Leaves are like those of *Amelanchier Lob.* green at Top and very woolly underneath, not running to a Point, as is common in others, but with an Indenture at the upper-end.

Desfontaines also named another species of the genus after Dampier, *Diplolaena dampieri*, a plant from the southwestern extreme of the continent that Dampier did not collect.

Although Dampier's natural history collections were made in Western Australia, the illustrations of flora and fauna included in *Voyage to New Holland*, are from New Guinea and Timor, as well as Australia. Dampier, using the standard practice of pre-Linnean naturalists, makes use of Latin polynomials in describing his discoveries. Some examples of this (Dampier 1703:108–112) are: *Solanum spinosum Novae Hollandiae Phylli foliis subrotundis*; *Fucus ex Nova Guinea Fluviatilis Pisanae J.B. foliis*, which refers to the seaweed *Sargassum binderi* (Fig. 16A); *Fucus ex Nova Guinea uva marina dictus, foliis variis*, referring to the seaweed *Sargassum ilicifolium* (Fig. 16B); *Equisetum Novae Hollandiae frutesceus foliis longissimis*, which probably refers to the Red Beefwood *Casuarina equisetifolia* (Fig. 16C); and *Colutea Novae Hollandiae floribus amplis coccineis umbellatim dispositis macula purpurea notatis*, which refers to the Sturt Pea, *Swainsona* (formerly *Clianthus*) *formosa* (Fig. 12E). Pertaining to his description of *Casuarina*, Dampier suggests that the plant may actually be other than a horsetail, and thus states, "Tis doubtful whether this be an *Equisetum* or not." Modern scientific names for Dampier's specimens are found in Cronin (1987), George (1981–1992), George (1999), and Morley & Toelken (1983).

Concerning the European discovery and description of the Australian flora, Pearn (2004) remarks:

> It should be pointed out that when William Dampier, on H.M.S. *Roebuck* in 1699 and when Captain James Cook and Joseph Banks on H.M.S. *Endeavor* in 1770, first explored in Australian waters, the western scientists and botanists encountered what they perceived to be a 'new' wonderland of flora. The botanists on H.M.S. *Endeavor* – Banks, Solander and the Forsters – simply had to row ashore with a collecting bag and a notebook. Every herb, moss, alga, fungus, shrub and tree was new to western science. Such were not of course to the Aboriginal Peoples of Australia, whom we now know for more than 40 millenia had developed an encyclopedic knowledge of the Australian flora and its properties.

Galápagos Islands (Figs. 5B, 6C)

More than a century and a half before Charles Darwin visited the Galápagos Archipelago in September and October of 1835, Dampier spent two weeks there exploring the islands (Slevin 1959; Larson 2001). He visited several islands in June of 1684 and took copious notes of his many

observations. Commenting on various aspects of the natural history of the islands, Dampier provided an early account of the Galápagos Tortoise:

> The Gallapagos Islands are a great number of uninhabited Islands, lying under, and on both sides of the Equator....I believe our Hydrographers do not place them far enough to the Westward....The Spaniards when they first discover'd these Islands, found Multitudes of Guanoes, and Land-turtle or Tortoise, and named them the Gallapagos Islands. I do believe there is no place in the World that is so plentifully stored with those Animals. The Land-turtle are here so numerous, that 5 or 600 Men might subsist on them alone for several Months, without any other sort of Provision: They are extraordinary large and fat; and so sweet, that no Pullet eats more pleasantly.

Dampier also provides second hand knowledge of the Indian Ocean tortoises:

> I have heard that at the Isle of St. Lawrence or Madagascar, and at the English Forest, an Island near it, called also Don Mascarin, and now possessed by the French; there are very large ones, but whether so big, fat, and sweet as these, I know not.

Dampier was also capable of rather straightforward botanical description, as in this case, probably referring to the Galápagos Candelabra Cactus *(Jasminocereus thouarsii)* (inset, Fig. 6C):

> the Eastermost [islands] are rocky, barren and hilly, producing neither Tree, Herb, nor Grass, but a few Dildoe-trees, except by the Sea-side. The Dildoe-tree is a green prickly shrub, that grows about 10 or 12 foot high, without either Leaf or Fruit. It is as big as a Man's Leg, from the root to the top, and it is full of sharp prickles, growing in thick rows from top to bottom; this shrub is fit for no use, not so much as to burn. [Dampier 1927:76]

Observations on Local Inhabitants

Regional Cultures

Dampier offers historical insight regarding the origins of the religiously divided Catholic north and Islamic south of the Philippines. He does so by providing a plausible explanation for the contemporary socio-political situation in the Philippines today (300 years later). In his description of Mindanao, Dampier relates:

> Many of the old People, both Men and Women, can speak Spanish, for the Spaniards were formerly settled among them, and had several Forts on this Island; and then they sent two Friars to the City, to convert the Sultan of Mindanao and his People. At that time these People began to learn Spanish, and the Spaniards incroached on them, and endeavoured to bring them into subjection: and probably before this time had brought them all under their Yoak, if they themselves had not been drawn off from this Island to Manila, to resist the Chinese, who threatened to invade them there. When the Spaniards were gone, the old Sultan of Mindanao, Father to the present, in whose time it was, razed and demolished their Forts, brought away their Guns, and sent away the Friars; and since that time will not suffer the Spaniards to settle on the Islands. [Damper 1927:226–227]

Dampier's often detailed descriptions of the customs of native peoples provide lucid insights into everyday life in various countries, such as this example from Mindanao, Philippines in 1686:

> The Common Food at *Mindanao* is Rice, or Sago, and a small Fish or two. The better sort eat Buffalo, or Fowls ill drest, and abundance of Rice with it. They use no Spoons to eat their Rice, but every Man takes a handful out of the Platter, and by wetting his Hand in Water, that it may not stick to his Hand, squeezes it into a lump, as hard as possibly he can make it, and then crams it into his Mouth. They all strive to make these lumps as big as

> their Mouth can receive them; and seem to vie with each other, and glory in taking the biggest lump; so that sometimes they almost choak themselves. [Dampier, 1927:225]

Dampier's makes observations on the customs of native Mindanaoans:

> The Women are very desirous of the Company of Strangers, especially of White Men; and doubtless would be very familiar, if the Custom of the Country did not debar them from that freedom, which seems coveted by them. Yet from the highest to the lowest they are allowed liberty to converse with, or treat Strangers in the sight of their Husbands. [Dampier 1927:224]

In a similar vein, while describing the inhabitants of the Con Islands, Dampier (1927:268) states:

> They are so free of their Women, that they would bring them aboard and offer them to us; and many of our Men hired them for a small Matter. This is a Custom used by several Nations in the *East-Indies*...

He says nothing of the reception of the gesture, or lack thereof, from the perspective of his ship's staff.

The following observation, described here by Dampier, shows an island in the Ceram Sea near the western tip of New Guinea to represent an ethnic border region between Malay and Papuan cultures:

> The Inhabitants of this Island are a Sort of very tawny *Indians*, with long black Hair; who in their Manners differ but little from the *Mindanayans*, and others of these Eastern Islands. These seem to be the chief; for besides them we saw also shock curl-pated *New-Guinea Negroes*; many of which are Slaves to the others, but I think not all.

Attitudes Toward Aboriginal Peoples

Between January and March of 1688 Dampier visited what is now the Dampier Peninsula in western Australia (Fig. 5A). Eleven years later in 1699, as captain of H.M.S. *Roebuck*, he explored the northwest coast of Australia from Shark Bay and Dirk Hartog Island to the Dampier Peninsula (Fig. 5A). From his two-month visit in 1688, he briefly commented on the standard of living of the aborigines he encountered there.

Some references have been made to Dampier's statements regarding Australian aborigines in works that help shape public perception, such as an encyclopedia entry of Winks (2000:24), who states:

> William Dampier...explored Australia and the far South Pacific and wrote one of the first English accounts of the region. His journal, *A New Voyage Round the World* (1697), helped increase English interest in the Pacific. He also increased racial prejudices when he wrote that the people living in Australia were 'the miserablest People' in the world.

Wink's criticism seems to be an unfair assessment, since other world travelers have made far harsher assessments of native peoples, but are rarely if ever criticized for promoting prejudice, and the subsequent impact of Dampier's statement on other individuals or events has been little explored (Preston and Preston 2004). Dampier was describing the economic situation of Australian aborigines and was not treating them as morally inferior.

A fuller account of Dampier's often quoted derogatory description is as follows: "The Inhabitants of this Country are the miserablest People in the World....And setting aside their

Humane Shape, they differ but little from Brutes." He made his observations in January of 1688, when his ship the *Cygnet* was grounded for repairs in Buccaneer's Archipelago. Dampier, along with his buccaneer colleagures, encountered a northern tribe of aborigines (perhaps the Bardi people) from the very arid and austere northwestern margin of the continent, where conditions for human survival were often extremely difficult. In contrast, eighty-two years later in August of 1770 in a more enlightened period, despite having read Dampier's report, Captain James Cook made a contrasting journal entry from the opposite side of the continent near Botany Bay, the vicinity of present day Sydney, where the environmental conditions were relatively benign and the local people consequently more affluent. Cook (*in* Grenfell Price 1971) wrote:

> From what I have said of the Natives of New Holland they may appear to some to be the most wretched People upon Earth, but in reality they are far more happier than we Europeans; being wholly unacquainted not only with the superfluous but with the necessary Conveniences so much sought after in Europe, they are happy in not knowing the use of them. They live in a Tranquility which is not disturb'd by the Inequality of Condition: The Earth and sea of their own accord furnishes them with all things necessary for life....

In a similar vein, more than a century and a half after Dampier, Charles Darwin (1845) referred to some of the people living in Tierra del Fuego as "stunted, miserable wretches", and subsequently remarks:

> I believe, in this extreme part of South America, man exists in a lower state of improvement than in any other part of the world.

He also remarked on indigenes of southern Africa:

> Some of the tribes of Southern Africa, prowling about in search of roots, and living concealed on the wild and arid plains, are sufficiently wretched.

Regarding Australian aborigines, Darwin continues:

> The Australian, in the simplicity of the arts of life, comes nearest the Fuegian....Although the Australian may be superior in acquirements, it by no means follows that he is likewise superior in mental capacity: indeed, from what I saw of the Fuegians when on board, and from what I have read of the Australians, I should think the case was exactly the reverse.

It should be pointed out that the Fuegian's propensity and success for survival in one of the world's harshest environments, would no doubt be superior to that the Victorian Englishman stripped of his technological advances. Gould (1991) comments on some of Darwin's statements pertaining to race, women, and native cultures, and describes the dominant theme of Darwin's writing pertaining to such matters as paternalism. Although Darwin rejected a *scala naturae* regarding taxonomy, he apparently did reserve such an arrangement as a scale of civilization to rank various cultures and societies that he encountered during the voyage of the *Beagle* in the 1830s. As an example, he ranked the Maoris of New Zealand highter than the Tierra del Fuegians but lower than the Tahitians (Ghiselin, in press). Gould (1991:14) refers to Darwin's writings:

> But his basic belief in a hierarchy of cultural advance, with white Europeans on top and natives of different color on the bottom, did not change.

Dampier does not show animosity in his writings toward indigenous peoples. In fact, he actually held rather enlightened views toward native cultures for his time, and portrays a compassionate concern for oppressed peoples. He wrote:

> All of the Indians that I have been acquainted with who are under the Spaniards seem to be more melancholy than other Indians that are free; and at these public meetings when they are in the greatest of their jollity, their mirth seems to be rather forced than real. Their songs are very melancholy and doleful, so is their music; but whether it be natural to the Indians to be thus melancholy or the effect of their slavery, I am not certain. But I have always been prone to believe that they are then only condoling their misfortunes, the loss of their country and liberties, while although those that are now living do not know nor remember what it was to be free, yet there seems to be a deep impression in their thoughts of the slavery which the Spaniards have brought them under, increased probably by some traditions of their ancient freedom. [Kirkpatrick 1907–21; Bartleby.com (website):2].

Prejudice was not a trait of Dampier's observational skills, as he had a more dispassionate and objective quality to his attention, which distinguished him from his contemporaries. Regarding Dampier's scientific approach, Preston and Preston (2004) explain, "Dampier's lack of prejudice and inextinguishable curiosity made him an instinctive, intuitive naturalist."

Buccaneer and Sea Captain

Piratical Escapades

"A skilled navigator, keen explorer and dedicated scientist,
William Dampier is best known as a buccaneer." — (Burton, et al., 1992)
"Dampier, William 1652–1715 Eng. buccaneer & navigator."
(Merriam Webster's Collegiate Dictionary, tenth edition)

Nations such as England had mixed feelings concerning piracy in the late seventeenth century. Although considered criminal activity to be condemned on the one hand, a previous era of buccaneering had shown a potential for a rapid return of riches and significant contributions paid to the royal coffers. Sir Francis Drake was knighted for such loyal activity! Buccaneering and later privateering provided nationalistic and capitalistic advantage to nations such as England and France. The late 1600's was a time of transition between traditional buccaneering and the full blown piracy of the 1700's. Wilkinson (1931:xxxiv) maintains a historical distinction between the two:

> The pirates were the degenerate descendants of the buccaneers. The appearance of the buccaneers as a fighting force …represented a formidable movement, a kind of international revolt, against the Spanish claim to a monopoly in the West Indies…They were landsmen for the most part — whereas the pirates were usually composed of the mutinous crews of trading vessels who had murdered their officers…The buccaneers, moreover, flew their various national flags and were often supported, and even rewarded, for their efforts by their own governments…after the treaty of 1670, when the Spanish claim was abandoned, at any rate theoretically, the profession of buccaneer inevitably began to fall into disrepute; until finally a point was reached when they were universally regarded as a pest…Those were the days of the pirates and the Jolly Roger…Now it is important to remember that Dampier's experience as a buccaneer falls precisely in the period of transition.

The oftentimes intimate interrelationship between war, national interest, and private enterprise, with privateering and war profiteering — the roots of which we can decipher during Dampier's time — has ominous overtones to us in the early 21st century. The last large-scale and successful privateering expedition — that of Woodes Rogers (in which Dampier served as pilot) ended in 1711. In that same year, the first outcome of the privateering movement saw the founding of the

South Sea Company, created by the British government to develop and consolidate the national interest (Williamson 1939:liv). The pre-Civil War American writer, Washington Irving, eloquently portrayed an historical perspective regarding piracy (Irving 1998):

> In old times, just after the territory of the New Netherlands had been wrested from the hands of their High Mightinesses, the lords States-Generals of Holland, by King Charles the Second, and while it was yet in an unquiet state, the province was a great resort of random adventurers, loose livers, and all that class of haphazard fellows who live by their wits, and dislike the old-fashioned restraint of law and gospel. Among these, the foremost were the buccaneers. These were rovers of the deep, who perhaps in time of war had been educated in those schools of piracy, the privateers; but having once tasted the sweets of plunder, had ever retained a hankering after it. There is but a slight step from the privateersman to the pirate; both fight for the love of plunder; only that the latter is the bravest, as he dares both the enemy and the gallows.

Selcraig (2005:83) defines priavateers as, "in effect, legalized pirates for the British Crown."

Whatever the fine distinctions of the degree of piracy may be, a plethora of English language euphemisms developed, perhaps due to changing attitudes and the desire to define the various aspects of piracy over time. The list of such synonymous terms for buccaneer and pirate is impressive and includes: adventurer, a robber on the high seas, corsair, freebooter, privateer, picaroon, rover, sea dog, sea robber, sea rover, and sea wolf; along with the related and less complimentary terms: raider, looter, marauder, pillager, and plunderer.

It is interesting to note that the word 'escapade' defined as an "adventurous action that runs counter to approved or conventional conduct," is reported to have come about in the English language around the year 1672, during the heyday of the buccaneers. This was at a time when Dampier joined the British Navy to serve in the Second Dutch War, and about seven years before he first met up with buccaneering captains such as John Coxon and Bartholomew Sharp in Negril Bay, Jamaica (Gray, 1927:xvi). The sense of the word has developed from, "Act by which one breaks lose from the rules of propriety and good sense" (*Webster's International Dictionary*, 1890:509) to "a usu. adventurous action that runs counter to approved or conventional conduct" (*Merriam-Webster's Collegiate Dictionary* 1996:395).

Dampier's actual role as buccaneer is debatable. The most likely explanation for this aspect of his life is that he found traveling with such individuals as a convenient, if not the only, mode of travel in remote areas, and possibly as a source of revenue to help finance his field research plans. By the time the British Admiralty gave him command of a ship, the H.M.S. *Roebuck*, and a government sponsored scientific expedition, dependence on the buccaneering way of life had become unnecessary for Dampier. However, perhaps as a consquence of his court-martialing in the British Navy stemming from an incident on his second voyage, Dampier once again joined the company of privateers during his third and fourth voyages, including service as pilot to such a notable captain as Woodes Rogers. The piratical aspects of Dampier's life are corroborated by the writings of his colorful comrades such as Basil Ringrose, Lionel Wafer, William Ambrosia Cowley, Bartholomew Sharp, John Cox, and perhaps his closest associate Woodes Rogers.

In his first book, *A New Voyage Round the World*, Dampier does from time to time hint at his predisposition, and that of his companions, toward piracy against the Spaniards. During an anchorage at Mindoro in the Philippines (Fig. 6F) in February of 1687, Dampier freely admits their true intentions, while relating a story of meeting Philippino traders from Manila. "We told them that we came for a Trade with the Spaniards at Manila, and should be glad if they would carry a Letter to some Merchant there, which they promised to do. But this was only a pretence of ours, to get out of them what intelligence we could as to their Shipping, Strength, and the like, under Colour of

seeking a Trade; for our business was to pillage." A few days later, off of Manila, Dampier relates, "we took another *Spanish* Vessel that came from the same place as the other. She was laden with Rice and Cotton-Cloth, and bound for Manila also...The Master of this Prize was Boatswain of the *Acapulco* Ship which escaped us at *Guam*, and was now at *Manila*...how they were afraid of us there...We took these two Vessels within seven or eight Leagues of *Manila*."

Dampiers third and fourth voyages (1703–1711) were privateering ventures that circumnavigated the world. During the third voyage he was captain of the *St. George*, a Bristol privateer, but acted as pilot for Captain Woodes Rogers during his fourth and last voyage, which was comprised of two ships, *Duke* and *Dutchess*.

Privateering bridged the gap between government-sponsored buccaneering on the one hand and legitimate private enterprise on the other, and became influential in the realm of national interest. Williamson (1939:liv) states with regard to events in Britain in the early part of the eighteenth century, "In the sphere of national policy, as contrasted with privateering enterprise, the first fruit of the movement was the foundation in 1711 of the South Sea Company, chartered by the British government to organize and monopolize the prospective national interest."

An example of the gray area between piracy and national interest expediency, can be seen in George Anson's 1740–44 expedition to harass Spanish ships, in which the last capture of a Manila Galleon was claimed after England had once again declared war on Spain (Adams *in:* Walter, 1974).

Difficulties as Sea Captain

"As a navigator he [Dampier] was little short of a genius;
as a captain he was a disaster." — (Burton et al., 1992)

In much of Dampier's career as a mariner, he was often plagued with the rough, untrustworthy, sometimes mutinous crews that were common at the time, composed of roguish, interchangeable individuals who could have served in equal capacity on either pirate vessels or the newly created official research expeditions. This situation, coupled with his own morose personality, made for potentially volatile situations during his journeys, and in one instance lead to his court marshal for cruel treatment of an officer (Williamson, 1939). Gray (1927:xxiv) relates, "His [Dampier's] attitude towards the wild men with whom he associated was one of aloofness. His chief concern was the study of geography, the winds and tides, the plants and animals, and keeping his journal posted up."

Selcraig (2005:85) gives an account of Dampier's character:

> Handsome but peculiar, Dampier was one of history's most complex, and perhaps reluctant, pirates. Some saw him as a cruel, indecisive and incompetent sailor who once narrowly escaped being eaten by his own men in the Pacific and who was court-martialed after losing the British warship HMS *Roebuck* off the coast of Australia. He was often drunk on duty and would infuriate his crews by letting captured ships go free without distributing loot to his men. Yet his contributions as an amateur anthropologist and naturalist were considerable, and it's hard to minimize that he was the first man to circumnavigate the world three times.

In *A New Voyage Round the World*, Dampier makes a humorous reference to an incident at Guam, regarding the obvious and inherent dangers of traveling with a roguish crew, "At four a-Clock, to our great Joy, we saw the Island Guam, at about eight Leagues distance. It was well for Captain Swan that we got sight of it before our Provision was spent, of which we had but enough for three Days more; for, as I was afterwards informed, the Men had contrived, first to kill Captain

Swan and eat him when the Victuals was gone, and after him all of us who were accessary in promoting the undertaking this Voyage. This made Capt. Swan say to me after our arrival at Guam. Ah! Dampier, you would have made them but a poor Meal; for I was as lean as the Captain was lusty and fleshy."

Dampier's Influence on English Literature

Scholars have long recognized the importance of Dampier and his travels to several important contributions in English literature of the eighteenth century: Jonathan Swift's *Gulliver's Travels* (1726) (Fig. 17), Daniel Defoe's *Robinson Crusoe* (1719) (Fig. 18), and possibly Samuel Taylor Coleridge's *The Rime of the Ancient Mariner* (Bonner 1934; George 1999b).

The Ancient Mariner

The English poets William Wordsworth (1770–1850) and Samuel Taylor Coleridge (1772–1834) were both avid readers of travel literature. Two such travel books that apparently influenced the two poets were those of William Bartram (1791) and William Dampier (1703). Doren (1955:5) states, "Coleridge was indepted to [Bartram]...for many gorgeous images which later found their way into 'The Ancient Mariner', 'Kubla Khan', and lesser poems." Coleridge developed an early passion for reading by age five or six and is purported to have already read Defoe's *Robinson Crusoe*. Wordsworth and Coleridge collaborated during the early stages of theme development for a poem that eventually become *The Rime of the Ancient Mariner*. They found that their styles did not blend well, and Wordsworth subsequently gave the project up to Coleridge. An important contribution that Wordsworth made during their early collaboration, however, was the incident of the shooting of the albatross, which was based on an event that he had read about in a book of travels (Deutsch 1967:6).

George (1999:135) states, "Samuel Taylor Coleridge referred to him [Dampier] as 'a man of exquisite refinement of mind' and probably gained ideas and inspiration from him for *The Rime of the Ancient Mariner*. Could the albatross that the Mariner shot have had its origin in the petrel shot by Dampier?"

Dampier, 1703 (in: George 1999b:100) describes the shooting of a Pintado Petrel, (Fig. 15F) on the 7th of August 1699, off of western Australia:

> the true Pintado is curiously spotted white and black...We shot one a while after in a Calm, and a Water-Spaniel we had with us brought it in.

By comparison, from *The Rime of the Ancient Mariner*, Coleridge, 1798 (in: Bloom 2004:360) writes:

> 'God save thee, ancient Mariner!
> From the fiends that plague thee thus! —
> Why look'st thou so?' — With my cross-bow
> I shot the ALBATROSS.

Gulliver's Travels

It is considered likely by some authors such as Bonner (1934) and Burton, et al. (1992) that Swift (1667–1745) modeled his fictional character Captain Lemuel Gulliver and his travels (Fig. 17A, D) after Dampier. The degree of influence concerning Dampier on Swift's novel is speculative however, as the published statements pertaining to this subject include a range of postulations

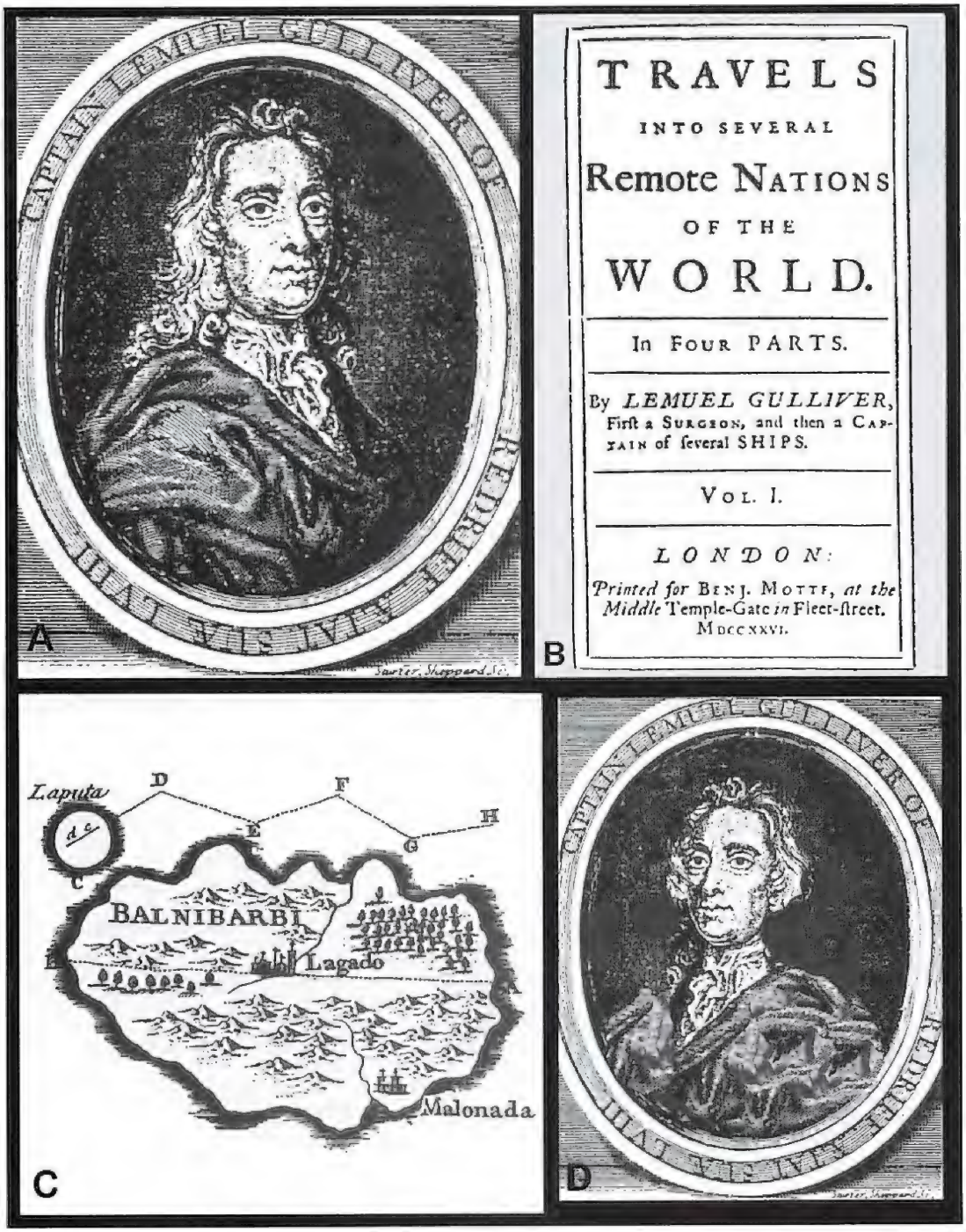

FIGURE 17. A. Captain Lemuel Gulliver, from the frontispiece of the first edition of Jonathan Swift's *Gulliver's Travels*, 1726. B. Title page of the first edition of *Gulliver's Travels*, 1726. C. Map from the 1735 edition of *Gulliver's Travels*, showing the artificial floating island of Laputa off the coast of Balnibarbi, and its manipulated trajectory. D. Captain Lemuel Gulliver, from the frontispiece of the 1735 edition of *Gulliver's Travels*.

FIGURE 18. A. Alexander Selkirk during his rescue from the Juan Fernandez Islands in 1709 (from Mégroz, 1939: pl. 6). B. The Moskito Indian William during his rescue from the Juan Fernandez Islands in 1684 (from Mégroz, 1939: pl. 3).

from rather tentative and cautious (Greenberg and Piper 1973) to stronger and more in depth analyses (Burton, et al., 1992). Greenberg and Piper (1973:iv) make a very brief reference as a footnote, "William Dampier (1652–1715), a noted explorer whose books on travel were widely read. Swift may have patterned some of Gulliver's traits after him." This rather unconvincing and timid view contrasts sharply with the opinion of Burton, et al. (1992:95), who treat the matter with considerable detail and point out some remarkable similarities between the travels of Dampier and Gulliver.

> Dampier's accounts of his voyages found an eager audience, and there is no doubt that they contributed to the work of both Daniel Defoe and Jonathan Swift. Swift's Gulliver, who was said by Sir Walter Scott to have the character of Dampier, or any other sturdy nautical wanderer of the period, pays two visits to New Holland, as did Dampier, and this same territory also features in Swift's *Tale of a Tub*. In a letter at the opening of *Gulliver's Travels*, Swift actually has Gulliver refer to Dampier. Moreover, both Gulliver and Dampier undertook four major voyages, the dates of two of which almost coincide. The Captain Pocock of Bristol whom Gulliver meets in Tenerife is a man going to Campeachy to cut logwood and must surely be based on Dampier.

Some of the major similarities between Dampier' career and Swift's *Gulliver's Travels*, previously pointed out by different authors, are detailed as follows. Dampier's worldwide expeditions occurred between 1679 and 1711, while Gulliver's period of travels was 1699 to 1715 — from Lilliput to Hounynymland. Both Dampier and Gulliver made a total of four expeditions in their traveling careers. Swift used the similar name "Drapier" as a pseudonym for Irish action letters. In *Voyages and Discoveries*, Dampier devotes a section to the description of his short-lived occupation of wood cutting in the Campeche region of Mexico, and similarly Gulliver makes reference to logwood cutting in the 'Bay of Campeachy' in the first paragraph of Part IV.

Authors such as Lloyd (1966:69) have pointed out additional evidence of support for Dampier as the real life model for Lemuel Gulliver, which is contained in the beginning of *Gulliver's Travels*, as *A letter from Capt. Gulliver, to his Cousin Sympson*. Swift begins:

> I hope you will be ready to own publickly, whenever you shall be called to it, that by your great and frequent Urgency you prevailed on me to publish a very loose and uncorrect Account of my Travels; with Direction to hire some young Gentlemen of either University to put them in Order, and correct the Style, as my Cousin Dampier did by my Advice, in his Book called, *A Voyage round the World*. [Swift, in: Greenberg and Piper, 1973:IV]

Lloyd (1966:69–72) also relates aspects of Swift's work as a parody of travel writing based on Dampier's, such as the geographic similarity between the places where Dampier and Gulliver visited, the possible relationship between Dampier's description of Australian Aborigines and Swift's Yahoos, and Swift's diatribe on imperialism — in imperialism, Dampier might arguably be held partly responsible.

Gulliver's Travels is perhaps one of the most effective and impassioned works of socio-political criticism in all of literary history. However, Swift's intentions were unfortunately sidetracked by the very subject of his diatribe. *Gulliver's Travels* was designed by Swift as a vehement satire of human nature. A large part of Swift's readership ignored his harsh social critique, and transformed the book into a children's story. Almost three centuries later, most people who know of *Gulliver's Travels*, think of this rancorous indictment of human behavior and English society as an amusing children's fantasy. It has become a famous children's book, but Swift obviously did not write it as such, intending it instead to be caustic social criticism. The wonderful imaginativeness and fantasy-like nature of his story, written as a travel documentary, no doubt gave an unintended

impetus for such a conversion. This event in itself can be seen as an example of denial — the refusal or inability to admit the reality of the major faults of human nature — one of the negative human attributes that Swift chose to critically describe.

The satirical nature of the book prompted Swift to exclude his name from the first edition, using Lemuel Gulliver as the pseudonymous author (Fig. 17B). Editions published for young audiences are invariably heavily edited and/or abridged. In one such version, the Junior Deluxe Edition (Swift, 1954), Swift's most impassioned example of social criticism — Part IV: A Voyage to the Country of the Houyhnhnms — is completely omitted. In this section, which is the source of Swift's most powerful critique of human frailties, Gulliver becomes distinctly antisocial and misanthropic.

Swift's exposé of human hypocrisy, deception, pride and dishonesty (among other things!), his disdain for the rapidly increasing wealth and power of the European merchant class, which was the precursor to modern capitalism, as well as the naively optimistic view of humanity by Enlightenment philosophers and Cartesian modernism, have kept literary critics occupied for centuries (Eddy, 1963). It is in fact probable that Swift's novel also satirized travel writing and voyages such as those of Dampier. Monk, 1955 (in: Greenberg and Piper 1973:631) defines Swift's work:

> *Gulliver's Travels* is a complex book. It is, of course, a satire on four aspects of man: the physical, the political, the intellectual, and the moral. The last three are inseparable, and when Swift writes of one he always has in view the others. It is also a brilliant parody of travel literature, and it is at once science fiction and a witty parody of science fiction. It expresses savage indignation at the follies, vices, and stupidities of men, and everywhere implicit in the book as a whole is an awareness of man's tragic insufficiency. But at the same time it is a great comic masterpiece, a fact that solemn and too sensitive readers often miss.

Swift chastised certain human traits that led to negative treatment and domination, such as jealousy and ambition at the expense of others. A number of serious faults of supposedly civilized nations with technological superiority and their aggressiveness toward other nations, were exposed in detail by Swift. Included here are selfishness, deception, and self-aggrandizement. Driven ambition and disagreeable traits resulting from bruised egos, produced little sympathy from the author of *Gulliver's Travels*.

The Aristotelian concept of the scale of being (*Scala Naturae*), which was largely accepted in one form or another between classical times and the Darwinian revolution, was used imaginatively by Swift in *Gulliver's Travels*. Monk, 1955 (in: Greenberg and Piper 1973:640) observes:

> Swift's attack on pride in the first two voyages is made more powerful because of his brilliant use of the chain of being...we become aware of our pettiness – of the disproportion of our race and of the shocking difference between what we profess and what we are...Swift uses the good giants ***[of Brobdingnag]*** to strike an unexpected blow at human vanity and to introduce a motif which he employed with deadly effect in the last voyage. That motif is disgust...Our beauty is only apparent; our disproportion is real.

In the fourth voyage, the belief from the scale of being that humans occupy the apex or highest position of the living world is dissected by Swift in the dichotomy established in Houyhnhnmland, where the civilized exterior of humans is only a superficial cover over the mind and body of a savage animal. The distinction becomes blurred between a human's exalted rational façade and the foundation of a beast.

Some social critics and commentators such as Abbey (1989) believe that it is the writer's duty to make the world a better place. However, a problem with taking on the role of an effective social critic is that one runs the risk of being stigmatized by threatened members of the status quo as a crackpot, a curmudgeon, or an iconoclast at best, or misanthropic, mentally ill, dangerously subversive, a menace to society, or all of the above, at worst. In fact, sixteen years after the publication of *Gulliver's Travels*, Jonathan Swift suffered a mental breakdown and was officially proclaimed *non compos mentis*, and was considered insane in the last three years of his life (Monk 1955:48). Swift apparently had Ménière's syndrome, a disease of the labyrinth of the inner ear that causes recurring attacks of nausea, dizziness, and deafness. This disorder no doubt contributed to his mental state of health. After nearly three centuries, whether Swift in later life was truly mentally ill or not is immaterial. What is of lasting importance is that he left a social thesis that is severely critical of the structure, values and exploitative nature of early eighteenth century English society and its political paradigm. The target of Swift's disdain can be seen as the English socio-political fabric in the strictest sense, or in a broader sense, any industrial culture with aggressive or imperialistic tendencies that by their nature tend to squash individualism. This is a social critique in fictional form that utilized the travel writing of William Dampier as a story foundation.

Dampier's introspective and perhaps antisocial nature is hardly evidence for misanthropy, but the record shows that he did have difficulties and failures as a sea captain, with the officers and rough-and-tumble crews chosen to travel with him. This aspect of Dampier's personality, which lead to his court martial in 1702, has been described in some detail by others (such as Williamson, 1939). He no doubt much preferred his time spent in the exploration of uncharted coasts, and the discovery and observation of new plants, animals, and indigenous peoples, to the often difficult company of his fellow Englishmen.

Swift's Gulliver, on the other hand, by his fourth voyage, had developed definite misanthropic views (Monk, 1955 in: Greenberg and Piper 1973:643). The split personality of humanity is graphically portrayed by the horse-like Houyhmhnms — symbolic of reason and rationality (the cerebral hemispheres of the brain), and the savage and physically human Yahoos — symbols of human animal nature (the "reptilian" core of the brain). The latter represents a contribution from *Gulliver's Travels* to our contemporary vocabulary. The word, "yahoo", was invented by Swift for the name of a tribe of naked savages, symbolic of the primal side of human nature, as related by Gulliver (Swift in: Greenberg and Piper 1973:198–199):

> The Master Horse ordered…one of his Servants, to untie the largest of these Animals, and take him into a Yard. The Beast and I were brought close together; and our Countenances diligently compared, both by Master and Servant, who thereupon repeated several Times the Word *Yahoo*. My Horror and Astonishment are not to be described, when I observed, in this abominable Animal, a perfect human Figure.

It is possible that Swift's vision of the savage Yahoos was influenced by Dampier's description of a particular band of indigenous Australians he encountered on the northwestern coast of the continent, as a people that "differ but little from brutes."

Dampier dedicated his 1699 book, *New Voyage Round the World*, to Charles Mountague, then president of the Royal Society. Dampier exemplified the clear observation and empiricism of a Baconian scientist (Larson 2001). In *Gulliver's Travels*, Swift parodied both travel writing and the scientific endeavor of Baconian philosophy. Swift was critical of the new scientific paradigm of the English Reformation and European Enlightenment, and he parodied both travel writing and the research promoted by the Royal Society in the third voyage of *Gulliver's Travels*. The Academy of Balnibarbi in the third part of *Gulliver's Travels* is modeled after aspects of the Royal Society

(Greenberg and Piper, 1973). Gulliver describes the nonsensical nature of some of the research conducted by Academy scientists.

The descriptive "philosophical Account" of the floating island of Laputa is a parody by Swift of the kind of scientific paper published in the *Transactions of the Royal Society* during the early eighteenth century (Greenberg and Piper 1973:140). Scientific aspects relating to Swift's Part III of *Gulliver's Travels* and his use of the *Transactions of the Royal Society* for his biting satire of science and scientists, are detailed by Nicolson and Mohler (1937).

The great imaginativeness of the third voyage in *Gulliver's Travels* (Part III) is shown by Swift's coding or linking of actual aspects of Swift's time by fictional aspects in his novel. Some examples of this symbolism are Laputa (political domination of the flying island), the Academy of Balnibarbi (the Royal Society), Glubdubbdribb (human history), and the Strulbrugs of Lugnagg (immortality). In addition, the locations and events that take place in Part I of *Gulliver's Travels* are often modeled after actual places and social or political circumstances or incidents of the early eighteenth century. Examples are Lilliput (England), Blefuscu (France), and Gulliver's fleeing from Lilliput to Blefuscu — which symbolizes the historical incident of Oxford and Bolingbroke in 1715 (Greenberg and Piper 1973:53).

Swift's work can also be seen as a parody of science and the intertwining of science with technology. Although Swift was not anti-science per se, he was obviously distrustful of the misuse of science and the concentration of political power. In *Gulliver's Travels*, the floating island of Laputa (Fig. 17C) was a technologically sophisticated domain, built and maintained by an on-board scientific/political elite.

As an example of the their scientific sophistication, Swift in his fictional account, predates the 1877 discovery of the two moons of Mars by 151 years, in this passage describing the observations of Laputan astronomers:

> They have likewise discovered two lesser Stars, or *Satellites*, which revolve about *Mars*; whereof the innermost is distant from the Center of the primary Planet exactly three of his Diameters, and the outermost five; the former revolves in the space of ten Hours, and the latter in Tewenty-one and an Half; so that the Squares of their periodical Times, are very near in the same Proportion with that of the Cubes of their Disance form the Center of *Mars*; which evidently shews them to be governed by the same Laws of Gravitation, that influences the other heavenly Bodies.

The Laputan hierarchy was an oligarchy out of touch with human needs and the aspirations of the majority, who made use of the aerial bombing of rebellious or non-cooperative populations below. It is certainly possible that Swift's name for the island, Laputa (La Puta is Spanish for "whore") refers to the prostitution or corruption of science for the goal of domination, using weapons of mass destruction. More than two centuries later, scientific/technological elites — Germany and the United States — using floating islands of their own: the V1 buzz bombs, V2 vengeance weapons, B-17 flying fortresses, B-29 bombers equipped with atomic bombs, and subsequent B-52 bombers, all proved Swift to be remarkably prescient. In a more contemporary context, the wanton destruction wrought by the "shock and awe" campaign of the United States government in the Tigris/Euphrates region, and the subsequent campaigns by insurgents of suicide bombings, videotaped executions, and deadly ambushes involving civilians, are hardly demonstrations of rational sophistication in human societies circa 2003–2006. The definition of "terrorism" by Reynolds (2005:165) is certainly readily applicable to both of the opposing forces in this conflict:

> Terrorism is violence that avoids combat, is used against the defenseless (often civilians), and is intended to shock and horrify, with the aim of bringing about social change.

Swift was certainly not the first storyteller to fictionally describe the political utility of flying islands as aerial weaponry for use in revenge or state terrorism against recalcitrant subjects. A similar situation in dealing with the potential threats of perceived enemies is seen in traditional Norse mythology. From a story entitled *The Blue Belt* told by Asbjørsen and Moe (1957:151), is found the passage, "In a little while came a great bird flying with an island in its claws and let it fall down on the fleet, and sunk every ship." The tendency for scientific and technological elites to use their superiority for power and domination over others has been treated by various historians and writers. Abbey (1968:149) relates a twentieth century example:

> Technology adds a new dimension to the process by providing modern despots with instruments far more efficient than any available to their classical counterparts. Surely it is no accident that the most thorough of tyrannies appeared in Europe's most thoroughly scientific and industrialized nation.

In Part III, Swift — through the voice of Gulliver — describes the use of the island as a destructive weapon and as an agent of political blackmail (Greenberg and Piper 1973:144).

> If any Town should engage in Rebellion or Mutiny, fall into violent Factions, or refuse to pay the usual Tribute; the King hath two Methods of reducing them to Obedience. The first and the mildest Course is by keeping the island hovering over such a Town, and the Lands about it; whereby he can deprive them of the Benefit of the Sun and the Rain, and consequently afflict the Inhabitants with Dearth and Diseases. And if the Crime deserve it, they are at the same time pelted from above with great Stones, against which they have no Defense, but by creeping into Cellars or Caves, while the Roofs of their Houses are beaten to Pieces. But if they still continue obstinate, or offer to raise Insurrection, he proceeds to the last Remedy, by letting the Island drop directly upon their Heads, which makes a universal Destruction both of Houses and Men. However, this is an Extremity to which the Prince is seldom driven, neither indeed is he willing to put it in Execution; nor dare his Ministers advise him to an Action, which as it would render them odious to the People, so it would be a great Damage to their own Estates that lie all below; for the Island is the King's Demes'n.

Robinson Crusoe

The link between one or possibly two incidents during the travels of William Dampier and another subsequent and equally famous work of adventure fiction, is unmistakable. Daniel Defoe's *Robinson Crusoe* is one of the great adventure novels in literary history. Defoe (1661?–1731) was raised as a Dissenter or Nonconformist. He was therefore banned from attending Cambridge or Oxford because of his religious beliefs, and was educated instead at the Dissenter's Academy. He started writing political pamphlets on religious and economic issues in 1683. He was arrested and jailed in 1703 for his published criticism of the Tory government. His most notable work was *Robinson Crusoe*, published in 1719, four years after Dampier's death. This was Defoe's first novel, which was highly successful, having gone through three printings in the first year of publication alone. The book first appeared as a true-life narrative, rather than as a fictional account, and remains still today as a literary classic (Ward 1995).

Defoe's fictional account is based, at least partly, on the true-life adventures of the Scottish seaman Alexander Selkirk (1676–1721) (Fig. 18A, 4C), who was marooned, at his own request, during Dampier's third voyage in October of 1704 and rescued four years later during Dampier's

fourth and last voyage in February of 1709. The event took place in the Juan Fernandez Archipelago off of Chile (Fig. 5B), on an island christened "Robinson Crusoe Island" in 1966 by the Chilean government. A first hand description of the Selkirk incident is aptly provided in the detailed account of Woodes Rogers (1712), as well as that of Edward Cooke (1712), as no account by Dampier is known to exist. Selkirk's habitation site was recently discovered by researchers high on an abandoned trail overlooking Cumberland Bay (Miller 2005:xvii–xviii).

Selkirk is an ancestor of present-day writer Bruce Selcraig, who detailed the Selkirk/Crusoe connection with new information (Selcraig 2005). According to his account, Selkirk's actual surname was Selcraig. The surname "Selcraig" is a relatively uncommon Scottish name. Documents of 1695 record his famous ancestor's name as Alexander Selchcraig, and subsequent historical accounts since Dampier's third voyage of 1703 record his name as Alexander (or Alex) Selkirk. This variation may have resulted because consistency regarding the spelling of names (and no doubt those of ship's crewmen) was not considered important in late seventeenth and early eighteenth century England.

Pertaining to the Selkirk episode, Burton et al. (1992:95) state:

> The link with Defoe is to be seen in the Alexander Selkirk story…and in the very nature of Crusoe's narrative, which goes into detail about the practicalities of life and work on the island in a style reminiscent of Dampier. Defoe's little-known last work has a name just like Dampier's first: *A New Voyage Round the World, By a Course Never Before Sailed*. It tells of a journey of circumnavigation dedicated to buccaneering, trade and discovery.

A previous incident that occurred during Dampier's first voyage, involved the marooning and rescue of a Mosquito (also as Moskito) Indian named "Will", also from Juan Fernandez Island (Fig. 18B). The story of this event, some twenty-five years before Selkirk's rescue, told by Dampier (1697) as well as by Ambrose Cowley (1705), may have provided the model for Defoe's character "Friday" in *Robinson Crusoe*, or part of a composite from which Crusoe himself was modeled. Gray (1927:xxxii) states:

> It is probable that Selkirk did not alone provide the suggestion of Robinson Crusoe. Defoe had also before him Dampier's account of the rescue of the marooned Mosquito Indian in Chapter IV [of *A New Voyage Round the World*].

Excerpts of Dampier's own detailed account of the incident are as follows.

> March the 22d 1684, we came in sight of the Island [Juan Fernandez], and the next Day got in and anchored in a Bay at the South end of the Island…We presently got out our Canoa, and went ashore to see for a *Moskito Indian*, whom we left here when we were chased hence by three *Spanish* Ships in the Year 1681…This Indian lived here alone above three Years…He had with him his Gun and a Knife, with a small Horn of Powder, and a few Shot; which being spent, he contrived a way by notching his Knife, to saw the Barrel of his Gun into small Pieces, wherewith he made harpoons, Lances, Hooks and a long Knife, heating the pieces first in the Fire, which he struck with his Gunflint, and a piece of the Barrel of his Gun, which he hardned; having learnt to do that among the *English*. The hot pieces of Iron he would Hammer out and bend as he pleased with Stones, and saw them with his jagged Knife; or grind them to an edge by long labour, and harden them to a good Temper as there was occasion…With such Instruments as he made in that manner, he got such Provision as the Island afforded; either Goats or Fish…He had a little House or Hut half a mile from the Sea, which was lin'd with Goats Skin...He had no Cloaths left, having worn out those he brought from *Watlin's* Ship, but only a Skin about

> his Waste…He saw our Ship the Day before we came to an Anchor, and did believe we were English, and therefore kill'd three Goats in the Morning, before we came to an Anchor, and drest them with Cabbage, to treat us when we came ashore. He came then to the Sea-side to congratulate our safe Arrival [Dampier 1927:65–67].

Defoe's belief in the superiority over barbarous nations and their peoples by technologically superior, capitalistic, civilized societies portrays an obvious distinction between his social paradigm and that of Jonathan Swift. This view of Defoe can be seen as the dominant view of the seventeenth and early eighteenth century western European establishment and power elite, both in the upper class and the rapidly developing middle class (Dennis 1964).

Dampier's Influence on British Science

Dampier as Scientist

Dampier was one of the first scientific writers that served a broad popular audience. Of important impact was the firm establishment of his reputation as hydrographer, with the publication of a treatise based on his personal observations of physical nature on a worldwide scale. He was one of the first such writers to recognize the effects of air circulation on surface currents. All of Dampier's writings show him to be remarkably well-traveled and observant.

The social context of the endeavor of science during Dampier's time should be kept in mind. Referring to the first half of the nineteenth century (approximately a century and half after Dampier's explorations), Shermer (2002:39) states, "The term scientist had not yet been invented, and most of those doing what we might think of as science would have thought of it as natural philosophy or natural theology."

Dampier's hydrographic treatise was obviously written mainly for mariners — information that aided one in traveling the world's tropical seas. His precise observations and descriptions related to empirical applied science, as opposed to what we recognize today as pure science. The paradigm to which Dampier subscribed was formed by the welding of the dual philosophies of 17th century Protestant Christianity with those of newly developing empirical science.

Dampier was a product of Baconian science and Protestantism — that amalgam of knowledge acquisition and religion that developed in the 17th century that promulgated the acquisition of knowledge to use for man's mastery over nature — the description of nature for the utility of man leading to an endeavor now known as applied science (Larson, 2001). Francis Bacon (1561–1626) was an English lawyer, parliamentary speaker, and philosopher, who attempted to explain the principles of acquiring knowledge. Baconian Protestantism professed empirical applied science, that is, the acquiring of knowledge for the use of mankind's dominion over nature, employing personal experience and observation. Dampier was acutely inculcated with the precepts of Baconian science. He mainly described natural history objects that could be eaten or used by man. As an example, he described in detail the edible Galápagos tortoises and sea turtles of the region, but he did not mention the unique marine iguanas, and other authors gave more detailed descriptions of the birds of the islands. Relevant to this, Larson (2001:27) explains:

> Dampier dedicated his book to Charles Mountague, the president of the Royal Society, and eagerly sought to conform it to that organization's scientific mission. In its 1663 charter, the Royal Society took as its purpose 'the advancement of the knowledge of natural things and useful arts of experiments, to the glory of God the creator and for application to the good of mankind.' Both elements of this purpose — finding in nature both divine design and human utility — reflected the influence of England's lord chancellor and leading philosopher of science, Francis Bacon, whose radical Protestantism inspired him to

> view the English Reformation as an opportunity for restoring humans to an Edenic position of total knowledge of and dominion over nature. 'The true end of knowledge,' Bacon once wrote, 'is a restitution and reinvesting (in great part) of man to the sovereignty and power (for whensoever he shall be able to call the creatures by their names he shall again command them) which he had in his first state of creation.'

Preston and Preston (2004) observe:

> ...Francis Bacon, who died in 1626...saw clear parallels between geographic exploration and the expansion of scientific knowledge.

The social and political environment in which Dampier lived and worked was also greatly impacted by the tumultuous 1600's, which saw the increasing power of Parliament and the subsequent abolition of that body by King Charles I, which led to civil war in the 1640's. England was therefore without a parliament for over a decade — during the 1630's. The country was also without a king for eleven years following the execution of Charles I in 1649. The brutal military general and statesman Oliver Cromwell (1599–1658) ruled the country as the Lord Protector of the Commonwealth of England from 1653–1658, serving as the head of a temporary but dysfunctional republic. After Cromwell's death, an appropriate successor as Lord Protector could not be established. Parliament then reinstituted the monarchy with Charles II as king, but with significantly reduced powers.

In his biography of the nineteenth century abolitionist John Brown, Reynolds (2005:164–165) relates similarities in the life of Brown to that of Cromwell:

> By mid-May1856 the events in Kansas and on the national scene made the Old Testament God of Battles seem more relevant to him than the New Testament's Prince of Peace. In this sense he followed the example of his greatest hero among white Christians, Oliver Cromwell....Cromwell, having led English Puritans to victory over the royalists, directed the beheading of the king (standard procedure in revolutions) and then committed war atrocities (*not* standard)...Brown, who often quoted Cromwell's phrase about trusting in God and keeping one's gunpowder dry, was familiar with the Puritan's leader's use of violence to enforce what he considered Christian principles.

This period of upheaval in the 1600s was part of a trend toward some degree of democratization that took place in Britain, with a greater voice acquired by a broader range of the population — a time when a gradually increasing political empowerment was gained by a parliamentary institution from an historical, autocratic or absolute monarchy. This convulsive political movement, together with the scientific and religious paradigm of Francis Bacon, certainly served to change British society and contributed significantly to the social environment of the late 1600's and early 1700's, in which Dampier was an important part.

Dampier's writings, particularly the publication of *A New Voyage Round the World*, made a significant impression on the British Admiralty, and lead to the first official expedition of scientific discovery — the voyage of H.M.S. *Roebuck*. This event in effect set the stage for Captain James Cook and a subsequent era of government sponsored scientific exploration. Gill (1997:8) states:

> Dampier started out on his travels 100 years before James Cook set out on his famous series of voyages of exploration; and Cook's achievements should be regarded as the apotheosis of the work of scientific exploration begun by Dampier.

Throughout much of his worldwide travels, Dampier kept fastidious notes on his observations. The precision, accuracy, and empirical nature of his journal entries did not become a commonplace

practice until after his death in the eighteenth century. The upkeep of his carefully written journal and diligent journal entries served to distinguish his abilities as an explorer and mariner in the British tradition, and certainly helped to bring about confidence and respectability regarding him, in the view of the British Admiralty.

Relevant to this, Burton et al. (1992:3) state:

> The book [*A New Voyage Round the World*] also brought Dampier to the attention of the Government, secured him a job at the Customs House, and won him recognition as an expert whose advice was sought by the Council of Trades and Plantations. The First Lord of the Admiralty was sufficiently impressed to invite him to suggest a destination and lead a type of expedition that was virtually unique at the time — a government-sponsored scientific voyage of discovery. Dampier chose New Holland and New Guinea...He was given command of a ship called the *Roebuck* with a crew of 50 men and boys and asked to make a collection of plant specimens and to bring home any native who might be willing to travel with him.

Finally, Gray (1927:xxxiv) quotes Admiral Smyth from the *United Service Journal* of 1837:

> The information he [Dampier] affords flows as from a mind which possesses the mastery of its subject, and is desirous to communicate it. He delights and instructs by the truth and discernment with which he narrates the incidents of a peculiar life; and describes the attractive and important realities of nature with a fidelity and sagacity that anticipate the deductions of philosophy. Hence he was the first who discovered and treated of the geological structure of sea coasts;...[see Figs. 9, 10B–C].

Dampier's influence on subsequent scientific voyages of discovery is nicely summarized by Williamson (1939:lvi–lvii):

> Through all this mental activity the leaven of Dampier was a working and indeed a vitalizing agent. For he alone of the English navigators had come to the fringe of the unknown...He also was pre-eminent in satisfying the mind that studied for delight, the imagination that fed itself on strange birds and beasts and peoples and glowing tropic scenes...In his life he was an antithesis, a shady adventurer, and untrustworthy colleague, a morose, unstable captain, who inspired neither affection nor respect; and at the same time the wielder of a pen of gold, which imparted...a gleam of humane and scientific enlightenment. Gradually the memory of Dampier the adventurer faded, while the genius of Dampier the writer continued to live. And, when, after half a century, the great age of the South Sea set in, and Byron and Wallis, Carteret, Bougainville and Cook revealed in fifteen years all the hidden mysteries, they did so in the best manner of the eighteenth century and not in its worst, approaching their task as civilized captains without envy or avarice, following the tradition of Dampier, the seeker of knowledge, untainted by that of the buccaneer.

Dampier's writing stands out among that of other chroniclers of his day. The scientific merits of his writing are extraordinary. He is always objective and scientific, virtually untainted by metaphysics, never embellishing or invoking supernatural causes for the natural phenomena that he encountered. Relative to this, Gill (1997:11, 239) states:

> Dampier's writing is phlegmatic, scientific, restrained: one occasionally wishes that a greater note of excitement would creep into it. But understatement, and calm observation of what he saw, is his great strength. It is just that sometimes such a style gets in the way of our ability to imagine the precise novelty of what he saw...his first major work...was an immediate bestseller, because it satisfied the voracious intellectual appetite of the

> time…But where many were fanciful, Dampier is always factual…He had brought a spirit of scientific exactitude to travel writing, and it was precisely in tune with the expectations of the educated late-seventeenth-century mind.

According to Hawking (1988:15, 179), it wasn't until the sixteenth and seventeenth centuries that empirical investigation (experiment and observation) became apparent (at least in the physical sciences):

> The Aristotelian tradition also held that one could work out all the laws that govern the universe by pure thought: it was not necessary to check by observation. So no one until Galileo bothered to see whether bodies of different weight did in fact fall at different speeds …. Galileo was one of the first to argue that man could hope to understand how the world works, and, moreover, that we could do this by observing the real world.

During the Roman Inquisition, which developed in the late 1500s and was responsible for the persecution of heretics, it was often dangerous to proclaim, empirically, deduced scientific views. Only a few decades before Dampier's birth, in the first half of the17th century, Galileo Galilei was forced to renounce his argument in favor of heliocentrism and was condemned to spend the rest of his life under house arrest. Alternative views to those held by the Catholic hierarchy regarding stablility of the surface of the earth as well as the origin of fossils, produced other tragic consequences. Berry (1968:17) explains:

> For those who tempted to express some doubt, there was the example of Giordano Bruno who was burned at the stake in Rome in 1600 for stating that there had never been a Deluge and that the positions of land and sea had changed many times. Bernard Palissy was another who had encountered the wrath of the clergy. He was denounced as a heretic for his statements that fossils were the remains of once-living animals and plants.

Dampier and Others

Several noteworthy scientists, writers, and mariners have held Dampier's work in high regard, or have credited him with significant contributions or impacts in science, natural history, navigation and literature. Included here are Alexander von Humboldt, E.E. Schmid, Charles Darwin, Jonathan Swift, Daniel Defoe, Samuel Coleridge, Sir Walter Scott, Lord Horatio Nelson and Captain James Cook. Dampier's interests crossed disciplines and included meteorology, marine hydrography, botany, zoology, anthropology, seamanship and geography. He was a pioneer of descriptive biology — considering his written accounts of tropical flora and fauna.

The German naturalist and traveler, Alexander von Humboldt (1769–1859), frequently used Dampier's contributions, while E.E. Schmid in his voluminous encyclopedia of physics of 1860 often made references to Dampier's meteorological observations and interpretations. Of the many books and references Charles Darwin accumulated in preparation for his writings on species, only four pre-1700 citations were included (other than Aristotle) — one being that of Dampier. Darwin often made reference to Dampier's observations during the voyage of H.M.S. *Beagle*, in the now famous red notebook in which Darwin recorded much of the founding material for his theory of natural selection. Darwin read several author's accounts of the Galápagos to prepare him for his visit of 1835 (Larson 2001).

Dampier's admirable trait of patient attention and his pioneering style of travel and scientific writing, were certainly reflected in subsequent works such as those penned by Darwin, including *The Voyage of the Beagle*. The widespread travels and keen observations of Dampier led him to recognize the concept of sub-species. Preston and Preston (2004:260) remark:

> The four types of "long legg'd fowls" he saw wading in the swamps were, he decided, as "near a-kin to each other, as so many sub-species of the same kind." This reference to *sub-species*, in the first volume of the book he would publish on the voyage in 1703, was the first public use of the term and indicated Dampier's continuing interest in the order and degrees of relationship within Creation.

Dampier remarked on the differences he observed between Caribbean and Galápagos Island green turtles, and found sub-specific distinctions among species of water birds in Brazil. This contribution was all the more remarkable in that it was conceived in a pre-Linnean, pre-Darwinian context.

Cartography

Greenhood (1964) described the map making process:

> Probably because of the technical applications associated with the term 'chart,' the science of making maps — from surveying to drawing — has come to be called *cartography* (chartography). It is a tool for geography, astronomy, and the many other studies and activities...As the invention of tools is epochal in human history, the invention of the map, which is probably the first intellectual tool, is preeminent in human development.

During the Age of Exploration, worthy accomplishment in cartography was fundamental to one's distinction or eminence in the art of navigation. Dampier was a skilled mapmaker. He drew charts based on his accurate navigational measurements and notes. Three of his published maps, showing the geographic details of the East Indies, the northeastern coast of New Guinea, and the Pacific Ocean, are notable examples (Figs. 3, 7B, 19).

The importance of accurate maps — and hence detailed geographic knowledge — regarding commercial interests and scientific exploration is obviously paramount. Many maps available during Dampier's time were fanciful or based on hearsay or unreliable information, or purposely included faulty details to deceive foreign explorers and governments. On the other hand, Dampier's maps were based on direct observations, and were obviously designed with a goal of accuracy. This is remarkable considering the fact that during Dampier's time, explorers did not have an accurate means to measure longitude. The capacity to measure longitude with a reliable degree of accuracy, did not come about until a half century after Dampier's death (Sobel 1995) (see discussion under the Scientific Works — Hydrography — Introductory Remarks).

Volcanism

Geological thinking concerning volcanoes during Dampier's time was puzzling and did not differ appreciably from the views introduced by classical scholars of ancient Greece and Rome – the belief that volcanic activity was the result of combustion and subterranean storms. Even so, some discerning insight resulted during the Roman period, as some philosophers such as Seneca (4 B.C?–A.D 65), believed that volcanoes were vents where molten material surfaced from subterranean reservoirs. The erratic and dual nature of great destructiveness coupled with the provision of fertile soil, and the great fear engendered by volcanoes, resulted in some cultures such as the Polynesians identifying gods with volcanic activity. An example is the Hawaiian demigoddess Pele who was sometimes young and beautiful, but when angered often ugly. In the Middle Ages, volcanoes were suspected of being gateways to hell or prisons for the damned. The word volcano is derived from the Mediterranean island of Vulcano (north of Sicily) and Vulcan — the Roman god of fire. The modern science of volcanology may have its roots in the 1754 eruption of Mount Vesuvius in Italy, where public interest and fascination were high (Boer and Sanders 2002).

In his travels, Dampier observed several live volcanoes on various islands and referred to them as "burning islands," reflecting the beliefs of the time regarding underground fire (Figs. 6H, 7B, 9). According to Preston and Preston (2004), Dampier's part time associate, buccaneer Ambrose Cowley, referred to the stark landscapes of the Galápagos Islands as, "sulphurous matter that had set them on fire, they having been burned formerly and some part of them burned up leaving piles of cinders." Some volcanic material he observed was referred by him as "a fine brimstone as fine as flour."

It was not until after Dampier's death that scientific observation began to mature our study and understanding of volcanoes, later to become known as volcanism or volcanology. This rapid development took place throughout much of the middle and late eighteenth century. The presence of crystals in some kinds of igneous rocks led to the erroneous Neptunian theory of the German geologist Abraham Gottlob Werner (1749–1817), which quickly became ideological orthodoxy. Neptunism was considered completely reasonable for the time, and lasted for half a century (Larson and Birkeland, 1982). The Neptunian doctrine, held that the Earth's first rocks ('primitive rocks') were of chemical origin, and had been deposited from solution as an ancient universal ocean evaporated. The dogma pertaining to this oceanic origin of rocks was named for Neptune, the Roman god of the sea. Werner later expressed the idea that volcanoes were abnormal but recent phenomena, caused by the subterranean combustion of coal or petroleum. It was later postulated that if surface basalts were primordial rocks of Neptunian origin, then the coal and petroleum necessary to melt rock could not be situated below them to cause volcanic activity. Among other traveling naturalists, the early nineteenth century observations of Alexander von Humboldt in the volcanic regions of South America, led to the conclusion that volcanoes were hardly rare and anomalous features restricted to modern times, but rather were widespread in space and time and could not have been induced by the burning of coal.

In the early eighteenth century, the intellectual environment regarding the origin of basaltic rocks could only be regarded as problematic and controversial. This was a period in which basaltic rocks were still referred to as whinstone (as in the fifteenth and sixteenth centuries) — the term basalt did not attain common usage until the 1800s. By the latter half of the eighteenth century, three individuals among others — The French geologists Nicolas Desmarest (1725–1815) and Jean-Étienne Guettard (1715–1786), and the Scottish geologist James Hutton (1726–1797), were largely responsible for clarifying our views regarding volcanism. Relevant to this, Williams and McBirney (1979) state:

> Credit for demonstrating the high-temperature origin of igneous rocks and for opening the way for modern volcanic geology goes to a handful of perceptive individuals working mainly in two places, central France and Edinburgh, Scotland.

Furthermore, Berry (1968:3) explains:

> Nicolas Desmarest had demonstrated that basalts in France were probably related to volcanic activity. [Giovanni] Arduino had noted that basalts were igneous in origin. Then Johann Voigt proclaimed that some of the very samples of basalt studied by [Werner] were not precipitates. This provoked the impassioned battle between Werner's followers, the "neptunists," and those who held that basalt had an igneous origin, the "vulcanists."

The French geologists published their findings in seminal papers — Guettard (1752) and Desmarest (1771), concerning observations that basalts were the same as lavas that were recently erupted from live volcanoes. They introduced the technique of using contemporary examples to interpret ancient rocks, which later became indispensable for geologic research — a principle sub-

sequently developed by James Hutton in which the present can be used as a key to the past. They also produced perhaps the first geologic maps that showed the geographic distribution of rocks, minerals, and fossils (Williams and McBirney 1979). In addition, Desmaret found many inclusions of granite in different stages of molten material and concluded that a progressive melting of granitic basements provided the raw material for volcanoes.

Hutton's work was also responsible for supplanting the Neptunian doctrine with his Plutonian theory. Due to the terrestrial nature of his observations relating to below-ground phenomena, the name of Hutton's theory was derived from Pluto, the Greek god of the underworld. From careful observations, he surmised that the upheaval of continents and mountains was due to subterranean heat over vast expanses of earth history. Hutton's gifted publicist was the eminent Scottish natural philosopher and mathematician, John Playfair (1748–1819). Playfair eloquently expressed Hutton's view in the 1802 publication, *Illustrations of the Huttonian Theory of the Earth*. The modern science of geology obviously owes much to the clear thinking empiricism of individuals such as James Hutton and John Playfair.

Meteorology

Much of Dampier's contributions in the field of what we now call physical oceanography are a combination of pioneering observations in meteorology and hydrography.

Many of the meteorological phenomena that Dampier observed, such as monsoons, cyclic storms, seasonal climatic patterns, regional weather phenomena, and air circulation, together with their influences on the ocean, are treated in detail in many sources, two of which are Donn (1975) and Lutgens, Tarbuck, and Tasa (2004).

The term meteorology is attributed to Aristotle in the third century B.C., but the science of meteorology during Dampier's time remained a vexing subject — as was the case with the geology of volcanoes. Simple observation of the sky was used since classical times for weather forecasting and a great deal of superstition still surrounded environmental phenomena. The hygrometer and barometer were only developed in the decade preceding Dampier's birth, while the mercury thermometer was not invented until a year before his death, although less sophisticated instruments to measure moisture and temperature were invented between the mid-fifteenth and the end of the sixteenth centuries. It was not until 1765 that relatively precise measurements of atmospheric parameters such as moisture content, temperature, and pressure of the air, as well as wind speed and direction, were made on a daily basis by the French chemist Antoine-Laurent Lavoisier (1743–1794). However, Gribbin and Gribbin (2004) maintain that the endeavor of "weather forecasting" was actually coined and invented by Captain Robert Fitzroy, captain of H.M.S. *Beagle* that carried Charles Darwin as naturalist from 1831 to 1836. In the mid-nineteenth century, the rapid transfer of weather data was made possible with the electric telegraph, while sophisticated weather maps with isobars and other weather symbols were introduced.

Dampier's penetrating observations of meteorological phenomena and their interactions with tropical oceans was accomplished solely by direct observation over many years of travel at sea.

SCIENTIFIC WORKS — HYDROGRAPHY

Introductory Remarks

Undoubtedly, the origins of the field of physical oceanography can be traced to the oral traditions of early mariners that gradually provided an amassment of vital practical knowledge for sea travel. Included here are the Polynesians and Micronesians of the western and central Pacific, Arabs in the western Indian Ocean, and Phoenicians, Carthaginians, and Greeks in the Mediterranean and Atlantic. Centuries later, a gradual development took place: the accumulation of detailed information on natural phenomena at sea, in the notebooks, logs, and journals of European mariners that was handed down over generations of maritime travel. These instructions for mariners based on careful observations included information on coastal winds, oceanic winds, seasonal weather conditions along particular coasts, tides, currents, storms, reefs, headlands, and offshore rocks and shoals: the whole gamut of geographic, meteorological and hydrographic data so necessary for successful and safer sea travel.

In the past, it had been generally accepted that the recorded observations of the Challenger expedition (1872–1876) provided the basis for the modern science of oceanography, as well as recognition and consolidation of its four components: physical, chemical, geological and biological oceanography (Guberlet 1964: 9; Tizard et al., 1885; Murray 1895). The accomplished crew of the H.M.S. *Challenger* was lead by Captain George Nares, and had a complement of seven scientists including Charles Wyville Thomson (1830–1882) as chief scientist (Williams 1999: 25, 28, 97, 102), along with John Murray (1841–1914), Henry Nottidge Moseley (1844–1891), John Young Buchanan (1844–1925), and Rudolph von Willemöes-Suhm (1847–1875).

However, the reports of the Challenger expedition were by no means the first published oceanographic works. Two important pre-Challenger contributions include that of a U.S. naval officer, Matthew Fontaine Maury (1855) on aspects of the physical oceanography of primarily the Atlantic Ocean, and Charles Wyville Thomson (1874) reporting on the results of deep-sea dredging operations of H.M.S. *Porcupine* and H.M.S *Lightning* between 1868 and 1870 in the northeastern Atlantic and Mediterranean.

> Certainly one of the most important expeditions prior to that of the Challenger was the U.S. Exploring Expedition, which circumnavigated the globe between 1838 and 1842 (It is important to note here that Darwin's around the world expedition on the board the H.M.S. Beagle took place from 1831–1836). James Dwight Dana (1813–1895) was the U.S. Exploring Expedition's geologist. As a result of his observations during the expedition, Dana was able to contribute significantly to the field of marine geology, subsequently called geological oceanography, particularly in the Pacific Ocean. He made many detailed observations concerning subsidence and uplift, coral growth, and the development of coral reefs. In Australia during the expedition, Dana read a newspaper account of Darwin's newly reported theory of atoll formation. Darwin's thesis formed a satisfactory explanation for what Dana had observed in the Pacific. Provided with this impetus, he added further evidence to Darwin's original thesis. Darwin thought that finding direct proof for subsidence of volcanic island, the prerequisite for atoll formation, was unlikely or impossible, but Dana subsequently found such evidence in Hawaiian shield volcanoes and the deeply eroded volcanoe of Tahiti (Viola and Margolis, 1985: 92). Perhaps Dana's most perceptive and illuminating contribution was his color-coded chart of the Pacific Ocean, in which green is used to denote areas of subsidence and red to mark areas of non-subsidence or uplift. The boundary that he recognized between the two regions in the west-central Pacific, corresponds remarkably well with the tectonic boundary (discerned by geologists some 115 years later), that marks boundaries between the Pacific Plate in the north and the Caroline, Bismarck, and Solomon Plates in the south (Dana 1849).

Between 1706 and 1708, the Italian naturalist Count Luigi Ferdinando Marsigli (1658-1730) conducted the first serious studies regarding underwater exploration. He used the traditional four-armed nets and scoops of the Mediterranean coral fisherman to sample benthic organisms on the ceilings of caves and overhangs, as well as bottom sediments (Edmonds 1997:201). He made an early study of the Mediterranean precious red coral, *Corallium rubrum* (Linnaeus, 1758), which was exploited and used widely for commercial and cultural purposes by various Mediterranean peoples since the Paleolithic (Allemand 1993). Marsigli's studies, published in 1725, pre-dated the *Challenger* by about a century and a half. In addition, the early use of dredges to study the benthic environment of northern European seas by a few northwestern European naturalists, pre-dated that of the *Challenger* by four to seven decades. The naturalist's dredge was introduced to science by the Danish naturalist O.F. Müller in 1799 as a modification of the fisherman's oyster dredge. It was later utilized virtually simultaneously in France by Henri Milne Edwards in 1830, in Britain by Edward Forbes in 1832, and in Norway by Michael Sars in 1835 (Herdman 1923:9).

The fundamental historiography of marine science by Margaret Deacon (1997) dispelled the myth that the voyage of H.M.S. *Challenger* marked the origin of modern oceanography, and showed that the mid-seventeenth century was a time of scientific revolution, with particular emphasis on the marine sciences. Deacon was also a proponent of the episodic nature of scientific change, in contrast to the notion of change through time as a linear and cumulative progress (Mills 1997:vii–viii). In 1962, Thomas Kuhn previously expressed this view in his seminal discussion of scientific revolutions with particular regard to the physical sciences — from Kuhn (1996:84, 92):

> The transition from a paradigm in crisis to a new one from which a new tradition of normal science can emerge is far from a cumulative process, one achieved from an articulation or extension of the old paradigm...the preceding discussion has indicated that scientific revolutions are here taken to be those non-cumulative developmental episodes in which an older paradigm is replaced in whole or in part by an incompatible new one.

A significant event regarding an episode of scientific achievement in Britain of the early 1600s was the development of collaborative efforts between mathematicians at Gresham College such as William Oughtred (1575–1660), Henry Briggs (1561–1630), and John Greaves (1602–1652), and the ship-building and naval hierarchies at Greenwich (Deacon 1997:69–70). Important British experimental contributions during this period include those of Robert Hooke (1635–1703) and Robert Boyle (1627–1691) regarding the properties of fluids, as well as the pioneering work of Edmund Halley (1656–1742) in meteorology, during a time in his career prior to his astronomical pursuits.

A subsequent and similar relationship of cooperativeness gave rise to technological achievements regarding the measurement of longitude in the first half of the eighteenth century. In England, the Board of Longitude was effectively convened in 1713, two years before Dampier's death, by offering prizes for the discovery of a technique that could accurately determine longitude. Fifty-three years later, John Harrison had perfected his original invention first developed in 1726, and introduced the chronometer in 1766. Harrison won first prize for his technological achievement, just two years before James Cook set sail on his first voyage. A detailed account of this episode is contained in Sobel (1995). Captain Cook had Harrison's chronometers on board, and therefore the technological advantage of accurate determination of longitude, while Captain Dampier, who ended his career at sea in 1711, did not. However, Dampier was able to competently circumnavigate the globe without the distinct advantage of later mariners, using careful observation, experience, and fastidious record keeping. Relative to this, Gill (1997:9–11) states of Dampier:

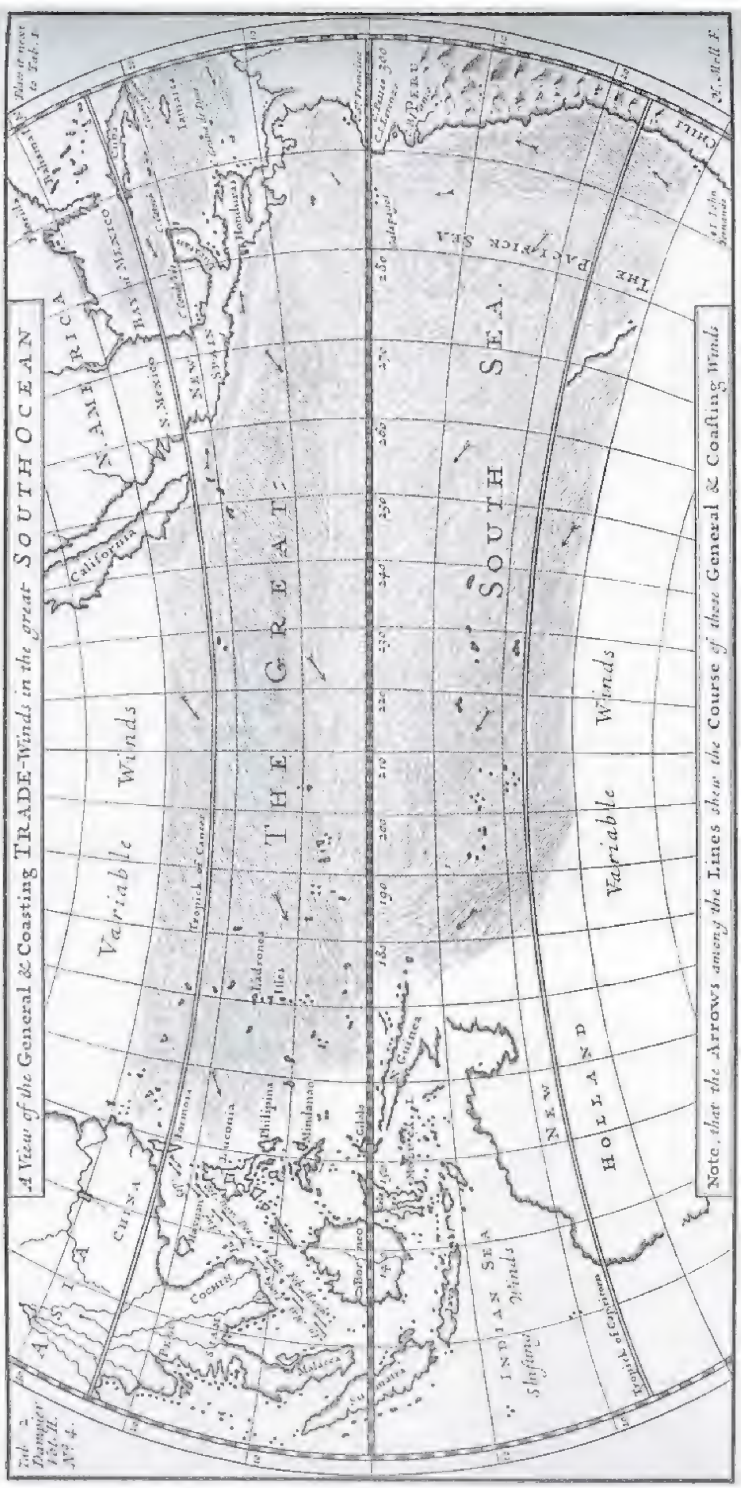

FIGURE 19. Dampier's map of trade winds of the tropical Pacific from, *A discourse of winds, breezes, storms, tides, and currents*, published in 1699 as part 3 of *Voyages and Discoveries*.

> It is worth looking at the world in which he lived...anyone setting out on a voyage of exploration was going into the unknown, especially when sailing in the Pacific Ocean, where Dampier pioneered, developing what was for the time a unique knowledge of that huge sea. Downie (1998:70) offers a brief biographical sketch of Dampier as pirate, but describes one aspect of his hydrographic contribution, ...

The remarkable thing about Dampier was that throughout his adventures and travels, he maintained his diaries. A meticulous recorder of places and events. His observations led him to be the first to identify the great ocean currents, not just as a local phenomenon, but as part of a worldwide geographical system.

The Treatise

A timely result of this period of blossoming interest in marine science was William Dampier's major hydrographic work, first published in 1699 (Figs. 11C, 19). This account, originally entitled, *A discourse of trade winds, breezes, storms, seasons of the year and currents of the torrid zone throughout the world*, but later shortened to, *A discourse of winds, breezes, storms, tides and currents*, was the first significant treatise on that blend of meteorology and marine hydrography that from our contemporary perspective we now call physical oceanography. The contents of the *Discourse* are outlined as follows:

Chapter 1 — Of the general trade-winds
Chapter 2 — Of the constant coasting trade-winds
Chapter 3 — Of the coasting trade-winds that shift
Chapter 4 — Of sea and land-breezes
Chapter 5 — Of land-winds and sea-breezes, peculiar to some coasts at some particular seasons of the year; as also of some winds that produce strange effects
Chapter 6 — Of storms
Chapter 7 — Of the seasons of the year
Chapter 8 — Of tides and currents
Postscript — Natal

Dampier's study on the tropical oceans was published one hundred and seventy three years before the *Challenger* set off on its epic journey, and from a modern retrospective should be regarded as a harbinger in the field of physical oceanography. This attribute has been all but lost in texts concerning the history of oceanographic science. For example, William Herdman (1923) does not even list Dampier in the index of his *Founders of Oceanography and Their Work*.

The Discourse was truly a first of its kind — a purely empirical contribution based on Dampier's careful observations and journal entries during twelve years of maritime experience, comprising his first major voyage and circumnavigation of the globe. Importantly, Dampier's one hundred and seven page work also established a landmark, in that metaphysics and supernatural causes were left behind, while the empiricism defined by objectivity and careful observation became all pervading, providing a path for the scientific era of the eighteenth and nineteenth centuries. Bell (1931:225) concluded:

> Modern hydrographic surveyors...ought especially to appreciate the extraordinary industry of a man who could write a complete handbook of ocean passages with no assistance but his own judgment and unrivalled knowledge of the sea.

Authors such as Deacon (1997) and Preston and Preston (2004) have recognized the significance of Dampier's treatise as a seminal work on hydrography of the world's oceans. The work

occupies a significant place in the literature of what we call today physical oceanography, that blend of marine hydrographical science and meteorology. It is a remarkable contribution, in light of the fact that it was accomplished in the midst of a philosophical environment when supernatural causes were commonly employed to explain natural phenomena. As described by Bell (1931:221):

> Scientific writers in the sixteenth and seventeenth centuries still wrote and thought under the influence of metaphysical traditions. They liked 'universal systems' and sought, as a rule, to explain natural phenomena by cosmic agencies...the source and origin of all their difficulties was ignorance.

In addition, Burton, et al. (1992:95) state:

> This showed Dampier's instinctive ability to understand natural phenomena, and it has been called a classic of the pre-scientific era.

Statements such as this one do not address one aspect of the historical record in that Dampier's period should be considered a scientific one and should not be labeled a "pre-scientific era" just because his works pre-date those of Linnaeus in 1758. Secondly, scientific writers biased by metaphysical points of view were not endemic to Dampier's era, but can be identified during subsequent periods as well — including the nineteenth and twentieth centuries.

Lastly, Deacon (1997:171) comments:

> Dampier was one of the few people to be able to write about the sea from a strictly empirical point of view and in his *Discourse of Winds*...he gave an account of conditions at sea based on his own experience. He was not concerned with theoretical discussion and controversy but with what he had himself observed....

Sea Winds and Storms

Dampier made detailed observations of trade winds near the equator. A term first used in the mid-seventeenth century, trade winds are winds that blow in a particular direction (such as westerlies). The eight chapters of Dampier's treatise describes in detail the following subjects: the general trade wind and constant coastal trade winds (Fig. 19), shifting coastal trade winds and monsoons, sea and land breezes, seasonal localized breezes and some that produce strange effects, storms (including hurricanes, typhoons, and stormy monsoons, seasonal effects in various regions of the world, and tides and currents. Among other things, he records the regional names used by various local peoples for unusual meteorological phenomena. Included here are the *Summasenta*[1] winds in the Bay of Campeachy, very fresh dry winds that can blow without cessation for as long as a week; the *Popogaios*[2] in southern Mexico, very brisk but non violent winds that blow day and night for three to ten days without intermission; the *Terenos*[3], extremely hot winds that blow non stop for three or four days on the Coromandel coast of India; and the *Harmatans*[4], exceedingly cold and piercing land winds on the coast of Guinea.

In the sixth chapter, Dampier describes the appearance of the sky during tropical cyclic storms. In our contemporary vernacular, three regional names are applied to such meteorological phenomena. These include **Hurricane** in the Atlantic and eastern Pacific — from the Taino Indian word "hurakan" — first introduced into western European languages in the mid-1500s; and **Typhoon** in the western Pacific — presumably derived from the Chinese for big wind "daaih-fung" or "ty-

[1] See page 636

[2, 3] See page 637

[4] See page 638

fung", the Greek word "typhon" for a violent storm or whirlwind, and the Arabic "tufan" for hurricane. In classical mythology, "Typhon" referred to the monster in Greek mythology with a tremendous voice — father of the sea monsters, the Chimera and the Sphinx. The word Typhoon was first spelled as such in the 1770's; Dampier used the spelling "Tuffoon"[5] in 1699. Lastly, the word **Cyclone** is used for other parts of the world such as the Indian Ocean and Australia, and sometimes also refers to a tornado. It is derived from the ancient Greek words "kykloma" or "kyklos" for wheel, coil, or circle - first used in the mid-nineteenth century. Meterologically, in the broad sense of the word, a cyclone is any organized area of low air pressure. Although tropical storms follow paths dictated by the Coriolis effect — clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere — as low pressure systems they rotate counterclockwise in the Northern hemisphere and clockwise in the Southern Hemisphere (Lyons 1997:25, 324).

Dampier's observations (before the days of aerial photography, remote sensing, and satellite imagery to record the cyclical shape, walls and eye of such a storm), were used by him to distinguish such a cyclical storm that originates at sea, from other kinds of storms, by the appearance of the clouds that precede the storm. He correctly considered both names to refer to the same phenomenon — "Hurricane"[6] in the West Indies and "Tuffoon" for the Philippines, China Sea, and East Indies.

> Tho' I have never been in any Hurricane in the *West-Indies*, yet I have seen the very Image of them in the *East-Indies*, and the Effects have been the very same; and for my part I know no difference between a Hurricane among the *Caribbee-Islands* in the West-Indies, and a Tuffoon on the Coast of *China* in the *East-Indies*, but only the Name: And I am apt to believe that both Words have one Signification, which is, *a violent Storm*.[7]

Dampier defines and describes the monsoon as storms that occur in the Bay of Bengal and the Coromandel Coast of eastern India in April and September. He identifies one of these events as the cause of his almost perishing in the Nicobar Incident, in which Dampier and a few companions survived passage in a small open boat from the Nicobar Islands to Sumatra during the April monsoon of 1688 (see Dampier's description of this incident in the present paper under the heading, *The Nicobar Islands*). In his description of monsoons, Dampier states, "It was in one of these that I past from *Nicobar* to *Sumatra*, mentioned in my *Voyage round the World*...This was the *April* Monsoon."[8]

Dampier describes a very terrible kind of monsoonal storm known by the Portuguese as elephantais, spelled by Dampier as elephanta or eliphanta:

> The Months of *July* and *August* afford very bad Weather, for then there is hardly any Intermission, but a continued troubled Sky full of black Clouds which pour down excessive Rains, and often very fierce Winds. But towards the braking up of the Monsoon, they have one very terrible Storm called by the *Portuguese* the *Eliphanta*, which concludes the bad Weather. For after that they put to Sea without fear of any more Storms that Season.[9]

Tides and Currents

The first seven chapters of Dampier's treatise deal with winds, storms, and seasons of the year — most useful information as a navigational guide for mariners. However, perhaps the most

[5] See page 642
[6] See page 646
[7] See page 648
[8] See page 648
[9] See page 649

FIGURE 20. Extensive effects of a spring low tide at Darwin Harbor (northern Australia); the city of Darwin is evident in the background. (Photograph by G.C. Williams, December 1990.)

thought-provoking and influential part of his discourse relates to chapter eight, his pioneering observations on tides and currents — a subject that in subsequent centuries became part of the field of physical oceanography. In this chapter, Dampier describes his careful observations from throughout the tropics on the movement of ocean water.

Whipple (1983) describes Dampier's work:

> ...*Voyages and Discoveries*...also included a sober section on his observations of the seas he had sailed. He clearly pointed out the distinction between tides and currents. 'By *Tides*', he wrote, 'I mean Flowings and Ebbings of the Sea, on or off any Coast.' In contrast: 'By *Currents* I mean another Motion of the Sea, which is different from Tides in several Respectes, both as to its Duration, and also its Course.' A steady, transoceanic current, in other words, is quite unlike the local twice-daily periodicity of a tide. Dampier suggested a probable cause of ocean currents: 'Tis generally observed by Seamen, that in all the Places where Trade-winds blow, the Current is influenced by them.'...If differences in air temperature were the primary cause of winds, then, in the Northern Hemisphere cold air would flow south from the Pole and warm air north from the Equator. (In the Southern Hemisphere, the directions would be reversed). Yet, as William Dampier had recorded in his *Voyages and Discoveries*, prevailing winds in the central North Atlantic take a southwestward course, while in the central South Atlantic a northwestward course is the rule.

Here, Dampier provides his observations on winds and ocean currents from both sides of the equator (fig. 19), on what was later to become known as the Coriolis Effect. Also known as the "turning effect due to earth rotation," this phenomenon was first effectively articulated by the French mathematician, Gaspard Coriolis (1792–1843), over a century after Dampier's death (Neshyba, 1987). Dampier's map of the tropical Pacific Ocean (a frontispiece to the first chapter of his treatise) clearly shows with arrows his observations regarding directions of the prevailing equatorial winds. With this, Dampier produced the first map showing in detail the winds and currents of the Pacific Ocean (Preston and Preston, 2004) [see Fig. 16 in the present work].

He was also able to distinguish between the less perceptible tides of oceanic islands and the larger ones of continental mainlands:

> I have also observed, that Islands lying afar off at Sea, have seldom such high Tides as those that are near the main, or as any Places on the Main it self; as for example, at the *Gallapagos Islands*, which lie about 100 Leagues from the Main: the Tides don't rise and fall above a Foot and half, or two Foot, which is less than they do on the Coast of the Main. For on most Places of the Main it rises and falls 2 or 3 Foot, more or less according as the Coast is more or less exposed to Indraughts or Rivers.[10]

Practical applications of hydrographic observations are often provided by Dampier, as in this example:

> In all my Cruisings among the Privateers, I took notice of the Risings of the Tides; because by knowing it, I always knew where we might best haul ashore and clean our Ships: which is also greatly observed by all Privateers.[11]

Here, rather than using a name with a more negative connotation, Dampier uses the more acceptable term 'privateer' — which bridges private enterprise with national interest.

Dampier, through careful observations, distinguishes examples in the field of the various tidal stages: **neap tide** — a tide of minimal range during the first and third quarters of the moon; **spring**

[10] See page 657

[11] See page 658

tide — a tide of maximal range during the full or new moon; **flood tide** — a rising tide; and **ebb tide** — a receding tide. Dampier states:

> The most irregular Tides that I did ever meet with, are at *Tonqueen* in about 20 d. North Latitude, and on the Coast of *New-Holland*, in about 17 d. South. In both these Places, the **neap** Tides are scarce discernable[12]...At New-Holland I had two Months time to observe the Tides. There the **Flood** runs E. by N. and the **Ebb** W. by S. And they rise and fall about five Fathom[13]...In all the **Spring**s that we lay here, the highest were three Days after the Full or Change, and that without any perceptible Cause in the Winds or Weather. I must confess we were startled by it; and though some of us had observed it in the Springs, that happened while we lay on the Sand to clean our Ship.[14]

Although Luis Vaez de Torres is credited with the European discovery in 1606 of the straight separating New Guinea from Australia, published maps showed a passage separating the two land masses as early as 1589 (Pacific Voyages 1971:243; Edmonds 1997:153), its existence was kept conjectural, due largely to Spanish reticence regarding the dissemination of geographical information outside of Spanish circles. Relevant to this, as late as1644, the Dutch navigator Abel Janszoon Tasman, was sent on a voyage to determine if New Guinea and Australia were joined as one land mass. Tasman was unsuccessful in the attempt. Forty-four years later, Dampier used his observations of tides during a two-month stay in northwestern Australia to determine by indirect means that such a straight may exist. Dampier's use of empiricism is implicit here — a combination of careful observation, his previous knowledge and maritime experience, and clear deduction.

> This I must also observe, That here was no River, nor Lagune, nor any other Indraught on the Land near us, that might occasion these great Tides: tho' 'tis very probable that the great Bending between New-Holland and New-Guinea, may have both Rivers and Lagunes, which may cause these great Tides; or else there may be a Passage of the Sea between both Places; as it is laid down in some Draughts: Or if neither of these, there may be at least a large and deep Sound. This is the more probable, because of the extraordinary Flood that sets to the East-ward in all that Sea, Between New-Holland, and the Islands lying North of it, which we most sensibly perceived, when we were near New-Holland: And such a tide as this must of Necessity have a greater Indraught than barely a River or Lagune; and 'tis the more likely still, that this Tide should have a Passage through between New-Holland and New-Guinea, or at least a deep Sound there; because it keeps along by the main, and doth not run in among the Islands to the North of it. And besides, the Northermost Promontory of New-Holland shoots down almost to the Line, which seems to be a Barrier to it on that side; therefore it may in Reason be supposed to have its Passage some other way; but of this guess, I have said enough.[15]

An extraordinary result of this phenomenon is illustrated in Fig. 20.

Although the *Discourse* is filled with practical sailing knowledge for circumnavigation of the world in tropical latitudes, it provides much more detailed meteorological and hydrographical information than is necessary for a mariner's guidebook, and in so doing, actually produces a hydrographic treatise.

For example, his treatise probably represents the first published account that clearly describes the relationship between winds and currents. Dampier states:

> Tis generally observed by Seamen, that in all Places where Trade winds blow, the Current is influenced by them, and moves the same way with the Winds; but 'tis not with a like

[12–14] See page 658

[15] See page 659

> swiftness in all Places; neither is it always so discernable by us in the wide Ocean, as it is near to some Coast; and yet it is not so discernable neither, very near any Coast, except at Capes and Promontories, that shoot far forth out into the Sea; and about Islands also the Effects of them are felt more or less, as they lye in the way of the Trade-Winds.[16]

Herdman (1923:175) and Deacon (1997:318–328) treat in some detail the controversy that ensued during the 1860's and 1870's concerning the theory of oceanic circulation and major currents such as the north Atlantic Gulf Stream, as well as the cause and origins of oceanic currents. The main players here involve Maury (1861), Carpenter (1870), Croll (1870–1874), and Wyville Thomson (1874), as well as the opinions of such notables as Sir John Herschel and Benjamin Franklin. It is indeed intriguing to note that more than a century and a half before the middle of this dispute, Dampier wrote:

> I have before hinted, That in all Places where the Trade blows, we find a Current setting with the Wind, which is not so perceptible in the wide Sea as nearer the Shores; yet even there the Force of the Winds constantly blowing one way, may, and probably does, move the Surface of the Water along with it.[17]

Herdman (1923:171) corroborates Dampier's premise with a modern explanation, "The direct frictional action of the wind is a prime factor in oceanic circulation."

Other notable contributions to oceanographic science include Dampier's distinction between surface currents and subsurface countercurrents based on his observations of the way the ship's cable was bent and pulled in different directions while at anchor, as well as his description of the powerful Agulhas Current off of southeastern Africa. Referring to subsurface currents, Dampier states:

> Neither is it any strange thing to see two different Currents at one place and time, the superficial Water running one way, and that underneath running a quite contrary: For sometimes at an Anchor, I have seen the Cable carryed thus by two different Streams, the under part having been doubled one way, and the upper part the contrary.[18]

Relating to ocean currents and counter currents from our contemporary perspective, we now know that primary (deep-water) circulation is driven by the sinking of cold polar water, and that with the threat of global warming, a significant altering of ocean currents, deep water circulation, and nutrient distribution is possible (P. Roopnarine and R. Van Syoc, pers. comm.).

Dampier's care for detail is seen in his account of what is now referred to as the Agulhas Current system, which is formed by the union of the Mozambique and South Equatorial Currents off the coast of Mozambique (Branch et al., 1994:1; Branch and Branch, 1981:14). Dampier writes:

> To the Eastward of the Cape *of good Hope*, from 30 d. South, to 24 d. South, the Currents from *May* till *Oct.* set E.N.E. and the Winds then are at W.S.W. or S.W. but from *Oct.* till *May*, when the Winds are between the E.N.E. and E.S.E. the Currents run to the West. These Currents are thus found from 5 or 6 Leagues off the shore to about 50. Within 5 Leagues off the Shore you have the Tide, and not a Current; and being past 50 Leagues off Shore, the Current either ceaseth quite, or is imperceptible.[19]

The fact that the monsoon in the Indian Ocean follows the path of direct sunlight across the equator was recognized by Dampier. He describes the lag period between the onset of the Monsoon north of the equator and the shift in ocean currents:

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[16] See page 659

[17] See page 661

[18, 19] See page 662

> On the Coast of India, North of the Line, the Current sets with the Monsoon, but does not shift altogether so soon, sometimes not by 3 Weeks or more, and then never shifts again till after the Monsoon is settled I the contrary way. As for Example, the West Monsoon sets in the middle of April, but the Current does not shift till the beginning of May: So when the East Monsoon sets in about the middle of September, the Current does not shift till October.[20]

Dampier's modest and self-effacing nature and his call to future observers is reflected in the last paragraph of his treatise:

> And thus I have finished what my own Experience...have furnished me with on this Subject of Winds, Tides, Currents, & which I humbly offer, not as a compleat and perfect Account, but as a rude and imperfect Beginnings or Specimen of what may better be done by abler Hands hereafter. And I hope this may be useful so far as to give a few Hints to direct the more accurate Observation of others.[21]

Conclusion

Dampier's pre-Linnean contributions to the exploration of the world's tropics, natural history, and physical science, are numerous and significant, but relatively underrated by historians. There is little doubt that the odious stain of piracy, as well as his many difficulties and failures as a sea captain, are at least partly responsible for portraying him in a negative light, and for under appreciating the importance of his many contributions in a pre-scientific era. Another important factor that should not be overlooked is the rigid class hierarchy that existed during Dampier's time. Accomplished individuals from relatively humble backgrounds such as Dampier and Woodes Rogers, would have had a disadvantage in being fairly recognized within such a social context.

Dampier worked at a time when his brand of objective travel writing based on worldwide exploration was a rarity with the general readership. His writings were based on accurate observations in an unaffected style of expressive prose that was admired by the public, as his books were best sellers during their time. His accomplishments are admirable in light of the fact that he worked for the most part under duress, often under hostile or life threatening conditions, that would have dissuaded, disheartened, or destroyed less determined and resourceful individuals. "He had the grit and the imagination that will take a man anywhere...", Clennell Wilkinson (1931:xxvii) has said of him, and he overcame great difficulties to contribute significantly to our knowledge of the natural world. He was a man happiest while in uncharted territory or directly engaged in the course of discovery. At the same time, he had a modest, unassuming personality and an abiding interest and desire to explore the Earth and record his observations for the good of scientific knowledge. He was able to portray this knowledge in an eloquent yet unpretentious style of writing in several popular and influential publications. He saw much of the world still largely in a state of wilderness, before industrialization – a relatively unpolluted world with low human population and impact – its inhabitants for the most part culturally isolated and distinct, prior to the effects of global homogenization.

Dampier's multidimensionality is remarkable. He wrote a seminal hydrographic treatise, which can be considered as an important early contribution in the field of physical oceanography. He was the first Englishman to set foot on the Australian continent, made the first Australian botanical collections, and consequently spawned British interest in the region. He captained the first offi-

[20] See page 662

[21] See page 663

cial British voyage of discovery. He explored and named many geographic features in northwestern Australia, northern New Guinea, and the Bismarck Archipelago. He was a major influence on eighteenth century English literature, particularly regarding Swift, Defoe, and possibly Coleridge. He was a superb navigator, observer, natural historian, and travel writer, who was wholly scientific in his genre of perceptive prose with an empirical approach.

In contrast, he spent most of his career in association with buccaneers and privateers, taking part in numerous piratical escapades in the Caribbean and Pacific arenas. As a ship's captain he was a poor leader, and was court-martialed by the British Admiralty and expelled as captain from the British navy for his mistreatment of an officer.

A Dampier memorial plaque erected in 1908 at his birthplace in East Coker (Fig. 21), Somerset, reads, "An exact observer of all things in Earth, Sea and Air he recorded the knowledge won by years of danger and hardship..." In a similar vein, Sir Albert Gray (1927:xxxv) said of Dampier, "He affords a bright example of strength of character in the pursuit of knowledge under the most adverse conditions."

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FIGURE 21. The Dampier memorial and commemorative plaques in the town of Broome, near Roebuck Bay, Dampier Land, Western Australia. Photographs taken January 2002 by Philip Alderslade (upper) and Leen van Ofwegen (middle and lower).

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Appendix 1

Chronology of Events Related to the Life of William Dampier

1651 (also recorded as 1652) — William Dampier born in East Coker, near Yeovil, Somerset, England
1662 — Dampier's father dies
1668 — Dampier's mother dies
1669/70 — Dampier becomes a shipmaster's apprentice at Weymouth, England, and serves as a seaman to France and Newfoundland
1671 — Dampier serves as a seaman to Java via the Indian Ocean
1672 — Dampier joins the British Navy and serves in the Second Dutch War
1674 — Dampier takes employment as a plantation manager in Jamaica
1675–1678 — Dampier employed as woodcutter in the Bay of Campeche, Mexico, and begins keeping a journal
1678/79 — Dampier marries Judith (surname uncertain) from the household of the Duke of Grafton
1679–1691 — First voyage (circumnavigation of the world — a twelve year voyage)
1681 — Dampier crosses the Darien Isthmus of Panama to escape a hostile situation with fellow buccaneers
1684 — Rescue of the Mosquito (Moskito) Indian named "Will" from the Juan Fernandez Islands
1688 (5 January) — Dampier first sets foot on Australian soil
1688 — Dampier with seven campanions, voluntarily leave a rebellious crew, and row an open canoe from the Nicobar Islands to the northern tip of Sumatra
1697 — Publication of *A New Voyage Round the World* by James Knapton, London
1699 — Publication of *Voyages and Discoveries*, Dampier's second book
1699–1701 — Second voyage (to Australia/New Guinea and back via the Indian Ocean) on the H.M.S. *Roebuck*, financed by the British Admiralty — the first official voyage of discovery.
1701 (25 February) — H.M.S. *Roebuck* sinks in Clarence Bay, Ascension Island
1702 (8 June) — Dampier's court martial and dismissal from the Royal Navy for "very hard and cruel usage towards Lieutenant [George] Fisher" on board H.M.S. *Roebuck*
1703 — Publication of the first part of *A Voyage to New Holland*, Dampier's third book
1703–1707 — Third voyage (to the South Seas and around the world), in which Alexander Selkirk is marooned on the Juan Fernandez Islands in 1705
1708–1711 — Fourth voyage (to the South Seas and around the world), including the rescue of Alexander Selkirk from the Juan Fernandez Islands in February 1709
1709 — Publication of the second part of *A Voyage to New Holland*
1715 — William Dampier dies at age 63, probably in London
1719 — Publication of the first edition of Daniel Defoe's *Robinson Crusoe*
1726 — Publication of the first edition of Jonathan Swift's *Gulliver's Travels*
1729 — Both parts of *A Voyage to New Holland* published together with continuous pagination
1729 — Publication of *Dampier's Voyages*, a four-volume collection that includes the seventh edition of *A New Voyage Round the World*, the fourth edition of *Voyages and Discoveries*, the third edition of *A Voyage to New Holland*, and the collected works of Funnell, Cowley, Sharp, Wood, and Roberts
1768–1780 — The three voyages of Captain James Cook

1906 — Publication of John Masefield's *Dampier's Voyages*, including F. Grant Richards reprint edition of *A New Voyage Round the World*

1927 — Publication of Argonaut Press edition of *A New Voyage Round the World*

1968 — Publication of Dover reprint edition of *A New Voyage Round the World*

1988 — Dampier memorial and commemorative plaques established at Broome, Western Australia, celebrating the tri-centennial of Dampier's first landing on the Australian continent (Fig. 20)

2000 — Tri-centenary commemorative celebration of the anchorage of H.M.S. *Roebuck* in the Shark Bay region, Western Australia, including the exhibition of 24 plant specimens at the Western Australian Museum. Perth, on loan from the Oxford University Herbarium

2001 (16 March) — Wreck of H.M.S. *Roebuck* discovered by an international team of divers in Clarence Bay, Ascension Island; three hundred years after sinking

2005 — Alexander Selkirk's habitation discovered and excavated on Robinson Crusoe Island, Juan Fernandez Islands, off the coast of Chile

Appendix 2

List of Taxa Named for William Dampier

Diplolaena R. Brown 1814 ANTHOPHYTA: RUTACEAE

(6 species endemic to the southwestern region of Western Australia)

Diplolaena dampieri Desf.

Type Locality: Cape Naturaliste, Western Australia

Distribution: southwestern extreme of Western Australia

Dampiera R. Br., *Prodr.* 587 (1810) ANTHOPHYTA: GOODENIACEAE

(66 species endemic to Australia); Type species: *D. incana* R. Br., *Prodr.* 588 (1810); type specimen collected by William Dampier in the Shark Bay area of Western Australia, August, 1699. See: George (1992: 34-80) for a detailed treatment of the taxa. The species with their respective ranges are listed as follows:

Dampiera adpressa	southern Queensland and northern New South Wales
Dampiera alata	southwestern Western Australia
Dampiera altissima	southwestern Western Australia
Dampiera angulata	southwestern Western Australia
Dampiera atriplicina	Gibson and Great Sandy Deserts of Western Australia
Dampiera candicans	western Western Australia to western Northern Territory
Dampiera carinata	southwestern Western Australia
Dampiera cinerea	Gibson and Great Sandy Deserts
Dampiera conospermoides	northern Western Australia and Northern Territory
Dampiera decurrens	southern Western Australia
Dampiera deltoidea	southwestern Western Australia
Dampiera dentata	central Western Australia
Dampiera discolor	central eastern Queensland
Dampiera diversifolia	southwestern Western Australia

Dampiera dysantha	southeastern South Australia and western Victoria
Dampiera eriantha	Great Victoria Desert of Western Australia
Dampiera eriocephala	southern Western Australia
Dampiera fasciculata	southern Western Australia
Dampiera ferruginea	eastern Queensland
Dampiera fitzgeraldensis	southwestern Western Australia
Dampiera fusca	northeastern Victoria southeastern New South Wales
Dampiera galbraithiana	central Victoria
Dampiera glabrescens	Wongan Hills region of Western Australia
Dampiera haematotricha	southwestern Western Australia
Dampiera hederacea	southwestern Western Australia
Dampiera heteroptera	southwestern Western Australia
Dampiera incana	western Western Australia
Dampiera juncea	southwestern Western Australia
Dampiera krauseana	Geraldton region of Western Australia
Dampiera lanceolata	southern South Australia and eastern New South Wales
Dampiera latealata	southern central Western Australia
Dampiera lavandulacea	southwestern Western Australia
Dampiera leptoclada	southwestern Western Australia
Dampiera lindleyi	southwestern Western Australia
Dampiera linearis	southwestern South Australia
Dampiera loranthifolia	southwestern Western Australia
Dampiera luteiflora	southwestern Western Australia
Dampiera marifolia	western Victoria and southeastern South Australia
Dampiera obliqua	Southwestern Western Australia
Dampiera oligophylla	Murchison River region of Western Australia
Dampiera orchardii	southwestern Western Australia
Dampiera parvifolia	southern central Western Australia
Dampiera pedunculata	southwestern Western Australia
Dampiera plumosa	south central Western Australia
Dempiera purpurea	southeastern Australia
Dampiera ramosa	Great Victoria Desert of Western Australia
Dampiera rosmarinifolia	southern South Australia and western Victoria
Dampiera roycei	central Western Australia and southwestern Northern Territory
Dampiera sacculata	southern Western Australia
Dampiera salahae	Geraldton region of Western Australia
Dampiera scaevolina	southwestern Western Australia
Dampiera scottiana	eastern New South Wales
Dampiera sericantha	southern central Western Australia
Dampiera spicigera	Perth region of Western Australia
Dampiera stenophylla	Great Victoria Desert of Western Australia
Dampiera stenostachya	southwestern Western Australia
Dampiera stricta	south and central eastern Australia and Tasmania
Dampiera sylvestris	southeastern Queensland & northeastern New South Wales

Dampiera tenuicaulis	southern Western Australia
Dampiera tephrea	Dongara region of Western Australia
Dampiera teres	Perth region of Western Australia
Dampiera tomentosa	southern Western Australia
Dampiera trigona	southwestern South Australia
Dampiera triloba	southwestern Western Australia
Dampiera wellsiana	southwestern Western Australia

Dampia pocilloporaeformis Alderslade, 1983 OCTOCORALLIA: ALCYONIIDAE
Type locality: Dampier Archipelago, Western Australia (Jurien Bay to Broome)
Distribution: Indo-West Pacific (Maldives to Great Barrier Reef)

Pacifigorgia dampieri Williams & Breedy, 2004 OCTOCORALLIA: GORGONIIDAE
Type locality: Isla Darwin, Galápagos Archipelago, Ecuador
Distribution: Darwin and Wolf Islands, Galápagos Islands.

Dampierosa daruma Whitley, 1932 TELEOSTEI: SYNANCEIIDAE
Dampier's Stonefish; endemic to northwestern Australia
Type Locality: Broome, Western Australia
Distribution: Endemic to northwestern Australia

Coryphaena hippurus subsp. *dampieri* Whitley, 1939 TELEOSTEI: CORYPHAENIDAE
A subspecies of the Common Dolphinfish named from Western Australia.
Dampier published an illustration of the Common Dolphinfish (Fig. 5C) sixty-one years before the description of Linnaeus.

Dampieria Castelnau, 1875:30. TELEOSTEI: PSEUDOCHROMIDAE
Dampieria lineata Castelnau, 1875, a synonym of *Labracinus lineatus* (Castelnau, 1875); The Lined Dottyback; endemic to Western Australia.
Dampieria is considered a synonym of *Labracinus* Schlegel, 1858, according to Hayashi in Masuda et al. (1984:140) and Eschmeyer (1998).

APPENDIX 3

Reprint of Dampier's *Hydrographic Treatise*

Editorial Note: *Dampier's* Discourse on Winds *was last reprinted in unabridged form in the Argonaut Press edition of 1931, which has become quite scarce and is not readily available. Thus, I consider it appropriate to reprint and annotate his treatise in the present paper, with a discussion of hydrographic science and other scientific fields relevant to Dampier's time, from a contemporary perspective. Comments and discussion concerning Dampier's treatise are contained in the above sections under 'Scientific Works — Hydrography'. Instead of using tedious and lengthy footnotes to edit Dampier's treatise, I resolved instead to use bolded numerals in superscript throughout parts of his treatise, that correspond to detailed additional material in the above section entitled* 'The Treatise.'

A Discourse of Winds, Breezes, Storms, Tides, and Currents

by William Dampier

CHAPTER I

OF THE GENERAL TRADE-WIND

The Introduction

Of the General Trade-Wind *at Sea. Of the best Time of the year to cross the* Equinoctial. *The Winds near the Line commonly uncertain, and attended with Calms and Tornadoes. A Reason of the Winds blowing South near the* Line, *in the* Atlantick Sea. *How Ships homeward-bound from the* Bite of Guinea, *should cross the* Line. *Of the* Trade-Wind *in the* South-Sea, *and in the* East-Indian *Ocean.*

I shall reduce what I have to say on this Subject to some General Heads; beginning with the Trade-Winds, as being the most remarkable.

Trade-Winds are such as do blow constantly from one Point or Quarter of the Compass, and the Region of the World most peculiar to them, is from about 30 d. North, to 30 d. South of the Equator.

There are divers sorts of these Winds; some blowing from East to West, some from South to North, others from West to East, &c. Some are constant in one Quarter all the Year; some blow one half of Year one way, and the other six Months quite contrary; and others blow six Months one way, and then shifting only eight or ten Points, continue six Months more, and then return again to their former Stations, as all these shifting Trade-winds do; and so as the year comes about, they alternately succeed each other in their proper Seasons.

There are other sorts, called Sea-Winds and Land-Winds, differing much from any of the former, the one blowing by Day, the other by Night, constantly and regularly succeeding each other.

Within the Torrid Zone also are violent Storms, as fierce, if not fiercer, than any are in other Parts of the World. And as to the Seasons of the Year, I can distinguish them there, no other way than by *Wet* and *Dry*; and these wet and dry Seasons do as successively follow each other, as Winter and Summer do with us.

Here are also strong Currents, sometimes setting one way, sometimes another; which though it is hard to describe, with that Accuracy which is desirable, yet I shall give as particular and Account of them, as also of the several sorts of *Winds*, as my own Observations, and the judicious Information from others, will afford me Matter to do.

Of the General Trade-Wind

Of all Winds before-mentioned, I shall endeavour to treat distinctly; beginning with the *True* Trade-Wind first, which I call the *General* Trade-Wind at Sea; because all other Trade-Winds, whether constant or shifting, seem to have their Dependance on some accidental Cause; whereas the Cause of these, be it what it will, seems uniform and constant.

These *General* Trade-Winds are only in the *Atlantick* Ocean which parts *Africa* from *America*, in the *East-Indian* Ocean, and in the *Great South-Sea.*

In all these Seas, except just under or near the Line, they constantly blow without Intermission, as well to the South, as to the North of the Equator, but not with equal Force at all Times, nor in all Latitudes; Neither do these constant Trade-Winds usually blow near the Short, but only in the Ocean, at least 30 to 40 Leagues off at Sea, clear from any Land; especially on the West Coast, or Side of any Continent: For indeed almost home to the Short; so near as to receie a Check from the Land-Wind, and oft-times to admit of the Sea-Breeze, by which it is drawn from its Course frequently four or five Points of the Compass: But of the Sea-Breeze I shall speak in its Place. In some Places, and particularly the South Seas, in South Lat. the true Eastern Trade is not found to blow within 150 or near 200 Leagues of the Coast, but in North Lat. In those Seas, it comes within 30 to 40 Leagues of the Shore: And this I shall give as a general Rule, that in North Lat. These Winds are commonly at E.N.E., in South Lat. at E.S.E.

When we go from *England*, and are bound to the *East* or *West-Indies,* or to *Guinea,* we commonly find these Winds in the Lat. of 30 d. sometimes sooner, as in the Latitudes of 32 or 35. And it may so happened that we may meet with an Easterly Wind in 40 d. or go out of our Channel with a North-East Wind; which sometimes also fails us not till we come into a true Trade-Wind; but this is only accidental, therefore is not the Wind that I speak of; but between 32 and 28 I did never know nor hear, that the true Trade-Wind failed.

If in coming from *England*, we have a North-Easterly Wind that brings us hither, (*i.e.* into the true Trade-wind) it sometimes stays at North-East, especially if we keep near the *African* Shore, as *Guinea Ships* do, till we are near the Tropick of *Cancer*, and then comes to the E.N.E. where it settles; but commonly it settles there in 29 d. if we are so far off Shore as to receive the true Trade. When the Wind is thus settled, we have commonly fair Weather, and a clear Sky, especially if the Sun is in any Southern Sign; but if in a Northern Sign, the Weather is usually cloudy.

On the contrary, when we are in South Lat. in the Atlantick, if the Sun is in Northern Signs, the Sky is clear, but if in Southern Signs, the Sky is cloudy. This I once experienced to my Sorrow, in my return from *Bantam*, in the Year 1671. We had cloudy Weather and brisk Winds, while we were crossing the *East-India* Ocean, and had a very good Passage also about the *Cape of Good Hope;* where we had fair clear Weather; And steering from thence, for the Island of St. *Hellena*, where we thought to water and refresh, as all our *English East-India* ships do, we mist it for want of an *Observation.* For before we came to the Tropick of *Capricorn*, the Sky was again clouded, so that we seldom saw the Sun or Stars, till we were quite past the *Island.* However we found the Isle of *Ascention* where we struck two Turtle, (for this was not the laying Time, but the beginning of the *Cooting* or Ingendring Season; therefore some few only were drawn hither). This was the latter-end of *November.* From the time that we thought our selves to the West of St. *Hellena,* we had our Water measured out to us, two Pints a Man *per Day*, till we came into our Channel. This was the first time that I began to know the Value of fresh Water; for we took in none in all our Way home from *Bantam.* But so much for this Digression.

The Winds, as I said before, as we run to the Southward from *England,* do first settle in the E.N.E. about the Lat. of 28 d. or be sure between that and 24 d. especially when the Sun is to the Southward of the Line; but in *May, June* and *July* you will find the Winds at E. by S. or E.S.E.

These Winds, whether we meet them to the North of the East, or to the South of it, we find blowing a moderate Gale from our first meeting them in 30 or 28 d. till we come to the Tropick, there we find the Trade stronger; It commonly blows a good Top-sail Gale, as we sail large; And if we were to sail on a Wind, our lower Sails would be enough.

These brisk Gales blow in the Atlantick Ocean, and North of the Equator, from the Lat. of 23

to 12 or 14 constantly, between the E.N.E. and the E. but between 10 or 12 degrees and the Line, they are not so fresh nor constant, to that Point; for in the Months of *July* and *August*, the South-Winds do oft-times blow even to 11d. or 12 d. of North Lat. keeping between the S.S.E. and the S.S.W. or S.W., but in *December* and *January* the true Trade blows between 3d. or 4d. of the Equator. And as the Sun returns again to the Northward, so the Southerly Winds do increase and draw more to the Northward of the Line, till *July*, and them gradually withdraw back again towards the Line: When the Sun is in Southern Signs, 'tis the best time of the Year to cross the Line, if bound to the Southward; for besides the Benefit of the true Trade, to bring a Ship near the Line, the Wind is then more constant and fresh, the Weather clearer, and the Winds which at other Times are between the S.S.E. and S.S.W. are now at S.E. or S.E. and by E., but in our Summer Months we find nothing but Calms and Tornadoes; and tho' Tornadoes do usually rise against the settled Wind; yet but few Commanders will endeavour to take the Advantage of the Winds that come from them, but rather furl their Top-sails, haul up their Corses, and lye still till the Gust of Wind is past, except Necessity requires haste; for the sudden Tornadoes do not continue long; and besides often very violent and fierce, so that a Ship with her Sails loose, would be in danger to be over-set by them, or at least loose Masts or Yards, or have the Sails split; besides the Consernation that all Men must needs be in at such a Time, especially if the Ship, by any unforeseen Accident, should prove unruly, as by the Mistake of the Man at Helm, or he that Conns, or by her broaching to against all Endeavours, which often happens when a fierce Gust comes; which tho' it does not last long, yet would do much Damage in a short Time; and tho' all things should fall out well, yet the Benefit of it would not compensate the Danger: For 'tis much if a Ship sails a Mile before either the Wind dyes wholly away, or at least shifts about again to the South. Nor are we sure that these Winds will continue three Minutes before they shift; and sometimes they fly round faster than the Ship will, tho' the Helm lies for it; and all Seamen know the Danger of being taken a-back in such Weather.

But what has been spoken of the Southerly Winds, Calms, and Tornadoes is to be understood of the East-side of the *Atlantick* to as far West as the Longitude of 359d. or thereabouts; for farther Westerly we find the Winds commonly at S.E. even in crossing the Line, and a very brisk Gale; 'tis for that Reason our experienced *Guinea* Commanders to keep to the Southward of the Line, till they are about that Longitude. Some run over nearer the *American* Shore before they cross the Line; Our *East-India* Commanders do also cross the Line, coming from *India* near the *American* Coast, and find brisk Gales at S.E. all the times of the Year; but going to the *Indies*, they steer away South, from the Island St. *Jago*, where they commonly water, and meet the Winds in that Longitude. But of this enough.

The Winds near the Line in the *Indian* Ocean and *South-Sea* are different from this, yet there the Winds are also Southerly, and therefore different from what they are farther off; for 2 d. or 3 d. on each side of the Line the Winds are commonly very uncertain, and oftentimes there are perfect Calms, or at least very small Winds and some Tornadoes in the *East-Indian* Sea. In the *South-Seas*, near and under the Line, the Winds are at South 130 Leagues off from the Short but how farther off I know not; there the Winds are but small, yet constant, and the Weather clear from *March* till *September*; but about *Christmas* there are Tornadoes; yet in both the *East-Indian* Sea, and the *South Sea*, the Winds near or under the Line, are often at South; yet these Winds do not blow above 2 or 3 d. to the North or South of the Line, except near some Land; but in the *Atlantick Sea*, as I have said before, the South and South-West Winds do sometimes blow even to 10 or 12 d. North of the Line. And for the South Winds to blow constantly near the Line in the *Atlantick*, between *Cape Verd* in *Africa*, and *C. Blanco* in Brazil, is no wonderful thing, if a Man will but consider those Promontories that shoot out from the Continents on each side of the Sea; one on the North, the other on the South-side of the Equator, leaving but a small space clear for the Winds to blow in;

where there is always a pretty brisk Gale, especially on the *American* side. And as within 2 or 3 d. of the Equator, it is most subject to Calms and Tornadoes, and small faint Breezes in other Seas not pent up as this is. So this Sea, except just in the very Opening between both Promontories, is much more subject to it than any other, especially on the East-side; that is, from the *Bite* or the Inland Corner of the Coast of *Guinea* to 28 or 30d. distance West: But this seems not to be altogether the Effects of the Line, but owing partly to the nearness of the Land to the Line, which shoots out from the *Bite* of *Guinea*, even to *Cape St. Anns,* almost in a Parallel with the Equator (allowing for the Bays and Bendings) and this is 23 or 24 d. of Longitude, and not above 80 Leagues from the Line in some Places: So that this part of the Sea between the Coast of *Guinea*, and the Line or 2 d. South of it, lying, as it were, between the Land and the Line, is seldom free from bad Weather; especially from *April to September*; but when the Sun is withdrawn towards the Tropick of *Capricorn*, then there is something better Weather there.

And in the Sea under the Line between the *African* Promontory and the *American*, it is free from Tornadoes and Calms, and more subject to fair Weather and fresh Breezes. Therefore both our *English* and *Dutch East India* Ships, when outward-bound, endeavour to cross the Line as near as they can in the mid-Channel, between both Promontories; and although they meet the Winds sometimes at S.S.E. or at S.S.W. or farther Easterly or Westerly; yet will they not run above a degree to the East, or a degree to the West of the mid-Channel, before they tack again, for fear of meeting with the soaking Current on the West, or Calms on the East-side; either of which would be alike prejudicial to their Course.

The *Portuguese* in their Voyages to *Brazil*, take the same method, and get to the South of the Line before they fall in with the Land, for fear of falling to leeward of Cape St. *Augustine*, for there are so many things which make that a difficult Cape to pass, that hardly any Man would try to do it, but at a distance.

But our *Guinea* Ships do generally pass on to their Ports on the Coast of *Guinea*, at any time of the Year, without using such Methods; because their Business lies mostly on the North of the Line, where they always find a fair Westerly Wind. But in their returns from thence, they cross the Line, and run 3 or 4 d. to the Southward of it, where they meet the Wind between the S.S.E. and the S.S.W. and a brisk gale: with this Wind, they run away in the same parallel 35 or 36 d. before they cross the Line again to the Northward, which is about mid-way between the Extreams of both Promontories, there they find a brisk gale, which carries them to the *West-Indies*, or where they please. Some run West 40 d. before they cross the Line, and find strong Gales; whereas should they come from *Old Callabar*, or any other Place in the *Bite*, on the North of the Line and steer away West, thinking to gain their Passage the sooner because it is the nearest way, they would doubtless be mistaken, as many Men have been: For if they keep near the Line, they meet with great Calms; and if they keep near the Land, they meet with Westerly Winds; and if they keep in the middle between both, they must of necessity meet with both Inconveniences, as also with Tornadoes, especially in *May, June, July and August.*

By which means some Ships, if they go any of these three ways now cautioned against, spend more time in going from the *Bite* to Cape *Verd,* than another Ship will do if it cross the Line in the right Places, before-mentioned, in going to the *Barbadoes*.

Sometimes unexperienced *Guinea* Masters in their return from Thence, after they have cross'd the Line from N. to S. and are in a fair way to gain a speedy Passage, will be so obstinate in their Opinions, after they have run 26, 28 or 30 d. West from *Old Callabar* (with a fair Wind) to steer away W. by N. or W.N.W. it being the directest Course they can steer for *Barbadoes*, then they must of Necessity keep within a Degree of the Line, while they are running 2 or 300 Leagues, which may prove to be a log time in doing, because of the Uncertainty of the Winds near the Equator;

therefor they that cross it near the Middle, between both Promontories, or near the *American* Coast, when they are minded to fall away to the Northward, steer away N.W. or N.W. by N. and so depress or raise a degree in running 28 Leagues at most; therefore (which is best) they are but a short time near the Equator: And besides, in thus crossing it in the middle between both Promontories, they seldom miss of a Wind: for the Wind in these Seas has no other Passage, but between these two Promontories.

What I have said already on this Head, has been chiefly of the *Atlantick*, and of that too mostly about the Line, because it is the most difficult Place to pass in going to the Southward. In other Seas, as in the *East-India Sea*, and the *Great South-Sea* there is no such Difficulty to pass any way, because there is Sea-room enough, without coming into such Inconveniences as we meet with in the *Atlantick*; and as to the Winds between the Line and the Tropicks, in the *East-Indian Sea* and the *South Sea*, they are in their Latitudes, as I said before, *viz.* in South Latitude, at E.S.E. and in North Lat. at E.N.E. blowing constantly fresh Breezes, especially in the *South-Seas*, even from within a Degree or two of the Line, on each side to the Tropick, or to 30 Degrees of Lat. And this I may truly say, that neither the *Atlantick* nor the *East-Indian Seas* have the true Trade-Winds so constant nor brisk at all times of the Year, and in all Latitudes, as they are here. For being once got in the Trade, I mean without the Verge of the coasting Trade-Wind, it blows a very brisk Gale all over the Ocean. Capt. *Eaton* experienced this in sailing from the *Gallapagos* Islands to the *Ladrones*, in the latter end of the Year 1685. We had the like Experience, sailing from *Cape Corientes* to *Guam* the Year after (as appears by my Journal of that Run, in my *Voyage round the World*, Chap. 10, Pag. 285 [197]). And as for the Wind to the Southward of the Line I had great Experience of it in my Ramble there with Capt. *Sharp*; and since that Capt. *Davis*, in his Return out of the *South-Sea*, had greater Experience, because he took his Departure from the *Gallapagos* Islands also, and steering W.S.W. from thence till he met the true Trade at E.S.E. he steered directly South, clear from the Line, till he got to the Southward of the Tropick of *Capricorn*, and so quite without the Trade.

In the *East-Indian* Sea, between the Lat. of 30 d. and 4 degrees South of the Equator, the true Breeze is at E.S.E. or S.E. by E. yet not so constant nor brisk as in the *South-Seas*; besides that part of it which lyes to the Northward of the Line, has not such a constant steady Breeze, but is more subject to Calms, and near the Shore to shifting Winds, according to the Seasons of the Year.

CHAPTER II

OF THE CONSTANT COASTING TRADE-WINDS

A Parallel of the South-Part of Africa *and* Peru. *The trade-Winds blow with an acute Angle on any Coast. The Winds about* Angola *and in the South-Seas alike; as also at* Mexico *and* Guinea. *The Winds shift not in some Places. Sand blown from the Shore about* Cape Blanco *in* Guinea. *An Account of the Trade-Winds from thence to* Cape Logos.

THE Trade-winds which blow on any Coast, are either Constant or Shifting.

The Coasts that are subject to Constant Trade-winds, are the South-Coast of *Africa* and *Peru*, and Part of the Coast of *Mexico*, and Part of *Guinea*.

The South-part of *Africa* and *Peru*, are in one Lat. both Coasts trending North and South; both on the West-side of their Continents; both in South Lat. and tho' they do not lye exactly parallel, by Reason of some Capes of Bendings in the Land, yet are the Winds much alike on both Coasts, all the Year long.

On the Coast of *Angola* the Winds are between the S.W. and S. And on the Coast of *Peru*, we

reckon them between the S.S.W. and S.S.E. But this the Reader must take notice of: That the Trade-winds that blow on any Coasts, except the North Coast of *Africa*, whether they are constant and blow all the Year or whether they are shifting Winds, do never blow right in on the Shoar, nor right along Shoar; but go slanting, making an accute Angle of about 22 degrees. Therefore as the Land trends more Easterly or Westerly from the North or South on these Coasts, so the Winds do alter accordingly; as for example, where the Land lies n. and S. the Wind would be at S.S.W. but where the Land lies S.S.W. the Trade would be at S.W. But if the Land lies S.S.E. then the Wind would be at South. This is supposed of Coasts lying on the West-side of any Continent, and on the South-side of the Equator, as the two Coasts of *Africa* and *Peru* are; but the North part of *Africa* has the Trade blowing off from the Short, two or three Points.

These Southerly Winds do blow constantly all the Year long, on both the Coasts of *Peru* and *Africa*; they are brisk, and blow farther off from the Coasts than any shifting Winds.

On the Coast of *Peru*, these Winds blow 140 or 150 Leagues off Shore, before you can perceive them to alter; But then as you run farther off, so the Wind will come about more Easterly, and at about 200 Leagues distance it settles at E.S.E. which is the true Trade.

Between *Angola* and *Brazil* the Winds are much as they are in the South-Seas, on the West-side of the *Peruvian* Coast; only near the Line, within 4 degrees of it, in South Lat. the Wind holds in the S.S.W. or S.W. for 28 or 30 d. of Longitude, and so it may in the same Lat. in the South-Seas, for ought I know; for it was at South, as far as any of us were, which as 200 Leagues.

As the Coasts of *Peru* and *Angola* have their constant Trade-winds, so has the Coast of *Mexico* and *Guinea*. And as the Coast of *Peru* lies North and South, so those lye nearer East and West. According to the Course of the general Trade, the Winds should be Easterly on these Coasts; but here we meet with the quite contrary; for from the Lat. of 10 d. North to 20 d. North on the Coast of *Mexico*, the Winds are constantly near the West on all the Coast, except check'd sometimes with Tornadoes, which do commonly rise against the Wind; the same is observed on the Coast of *Angola*, where there are Tornadoes also: But the Coast of *Peru* is not subject to any, yet on that Coast there are sometimes Calms two or three Days together off of the Bay of *Arica*, between the Lat. of 16 and 23. In the Lat. of 19 you shall have Calms 30 or 40 Leagues off Shore, but not so far on either side the Bay, neither are such Calms usual on the Coasts of *Angola* and *Mexico* only after a Tornado, as is common in other Places.

As the Coasts of *Angola* and *Peru*, do in most things run parallel each with other; so do the Coasts of *Mexico* and *Guinea*: And if I am not mistaken, the Winds on both these Coasts are much alike; Both these Coasts do begin at the Bit or Bending of the Land, where the other two parallel Lands do end; for as the *Mexican* Continent begins at or near *Panama*, which is eight or nine degrees North of the Equator; so that part of *Guinea*, which I speak of, begins about *Old Callabar*, in about four or five Degrees of North Lat.

The Land trends away Westerly from both these Places some hundreds of Leagues; and tho' not on one Point of the Compass, because of the small Points, Bays and Bending in the Land, yet the winds that on more regular Shores keep their constant Course, and blow in upon the Shore, about two Points from the Sea, do also here on the *Guinea* Coast, blow on the Shore from the West Quarter, and as the Land lies pointing in on the Shore, even from *Cape Mount* to *Old Callabar*; which is above 400 Leagues; and that with such Constancy that the East-part of that Coast is called the *Leeward Coast*; and the West-part the *Windward Coast;* And yet this is so contrary to the general Opinion of Seamen, concerning the Course of the Winds, that nothing but their own Experience will convince them of the Truth of it; for thus they generally reason; *Barbadoes* is the Easter-most of the *Caribbe*-Islands, therefore the rest are said to be Leeward of it, and so of any other Island; as indeed it usually holds true, because the Winds there are commonly at East; but this

Counter-Wind on the Coast of *Guinea* astonishes most Seamen that have seen nothing like what they meet with here. There are other Coasts where the Winds shift very little, as on the Coast of *Carraccos*, and the South-side of the Bay of *Mexico, i.e.* in the Bay of *Campeachy*, and all the *Caribbe* Islands. Indeed there may be sometimes some small Flurts of a Westerly Wind on these Coasts, but neither constant, certain, or lasting.

And indeed this was the great Stumbling-Block that we met with in running from the *Gallapagos Islands* for the Island *Cocos*, mention'd in my former Book, *Chap.* 5, *Pag.* 111 [82].

But that Part of *Africa,* which lies between *Cape Verd* in 14 d. North, and *Cape Bayedore* in 27, has commonly Northly Winds; or between the N. and N.E. very fresh Gales; therefore our *Guinea* Ships bound to *Guinea* strive to keep near that Shore, and oft-times make the Capes: And being to the Southward of *Cape Blanco*, which lyes in Lat. about 21, they are sometimes so troubled with Sand, which the Wind brings off Shore, that they are scarce able to see one another: Their Decks are also strewed with it, and their Sails all red, as if they were tanned with the Sand that sticks to them, it being of a reddish Colour.

From Cape *Verd* to Cape St. *Anns*, which is about 6 degrees North, the Trade is between the E. and S.E. from Cape St. *Anns,* to Cape *Palmas*, in about 4 d. North, the Trade is at S.W. from Cape *Palmas* to the *Bite* of *Guinea*, which is at the bending of the Coast, the Wind is at W.S.W. From this Bending the Land begins to turn about to the South; and from thence to Cape *Logos,* which is to the South of the Line, the Trade is at S.W. as it is on all that Coast, even to 30 degrees South.

This last Account I had from Mr. *Canby*, who has made many Voyages to *Guinea.*

CHAPTER III

OF THE COASTING TRADE-WINDS THAT SHIFT

The Coast where the Winds shift. Of the Winds between Gratia de Dios, *and* Cape La Vela. *Of those on the Coast of* Brazil: *At* Panama: *About* Natal: *And* Cape Corientes; *And the* Red-Sea: *From the* Gulph *of* Persia *to* Cape Comorin, *Of the* Monsoons *in* India: *Their Benefit for sailing from Place to Place, Sea and Land Breezes serviceable for the same purpose. By what helps long Voyages are made in an open Sea.*

THE Coast where the Winds do usually shift, are some in the *West-Indies*, as that part of the Coast between *Cape Gratia de Dios,* and *Cape La Vera* chiefly: The Coast of *Brazil*; the Bay of *Panama* in the *South Seas,* and all the Coast of the *East-Indies*, even from the River *Natal*, which is in the Lat. of 30 d. South, on the East-side of *Africa*, beyond the *Cape of Good Hope*, to the North-East Parts of *China*, comprehending all the Bays between. The Islands also have their Annual Changes; Of all these I shall treat in their order, beginning first with that Coast which lyes between *Cape Gratia de Dios* and *Cape La Vela*: And I the rather begin with this part first, because this part of the *West-Indies* is all that is subject to change; neither is the change altogether so orderly, or certain as the *Monsoons* in the *East-Indies,* or the shifting Winds on the Coast of *Brazil.*

The Common Trade-Wind on this Coast is between the N.E. and the East: This Trade blows constantly from *March* till *November*, but is often check'd with Tornadoes in the Months of *May, June, July,* and *August,* especially between the River of *Darien* and *Costorica*; but to Wind-ward there is a more serene Air, and a brisker Wind: From *October* till *March* there are Westerly Winds, not constant, nor violent, but blowing moderately, sometimes two or three Days or a Week; and then the Breeze may blow again as long. These Winds are most in *December* and *January*; before and after these two Months the Trade-Wind is only checked a Day or two near the full or change

of the Moon; and when the Westerly Winds blow longest and strongest on the Coast, the Easterly Trade-Wind blows off at Sea, as at other Times. Near *Cape La Vela*, the true Trade blows within eight or ten Leagues off the Shore, when the Westerly Winds blow on the Coast, except in a strong North, which turns the Trade-Wind back, and on the *Costorica*, and between it and the River *Darien* the Westerly Winds, as they are more frequent and lasting than toward *Cape La Vela,* so also they blow farther off at Sea, sometimes as far as to twenty or thirty Leagues from the Shore.

Therefore Ships bound to Windward, if they have far to go, either take the Opportunity of the Westerly Wind-Season, or else go through the Gulph of *Florida*, and stretch away to the North, till they get into a variable Wind's way, and then run to the Eastward as far as they think convenient before they stretch to the Southward again. All that are bound from the *West-Indies* to *Guinea* must take this Course, if they sail from *Jamaica* (because they must pass through the Gulph of *Florida*) but from other Islands they may stretch away directly to the North, and use the same Method.

But if Ships have only a small way to sail to Windward, they make use of the Sea and Land Breezes, making no account of the Time of the Year.

The Winds on the Coast of *Brazil*, are from *September* till *March* at E.N.E. and from *March* till *September* again they are at South

The Winds in the Bay of *Panama* are from *September* till *March* Easterly, and from *March* till *September* again they are at South and S.S.W.

From the *Cape of good Hope* Eastwards, as far as the River *Natal*, which lies in 30 d. South Latitude, and *Cape Corientes* in Lat. of 24 d. degrees South, the Winds from *May* to *October* are constantly from the West to the North West within thirty Leagues of the Shore: They blow hardest at North West. When the Wind comes to North West, it is commonly stormy and tempestuous Weather, attended with much Rain, and then the Weather is cold and chilly. From *October* till *March* the Winds are Easterly from the E.N.E. to the E.S.E. you have then very fair Weather: The E.N.E. Winds are pretty fresh, but the Winds at E.S.E. are small and faint, sometimes affording some drops of Rain.

From *Cape Corientes* to the *Red-Sea*, from *October* till the middle of *January* the Winds are variable, but most times Northerly, and oft shifting round the Compass: The strongest Winds are at North; these are often very violent and stormy, and accompanied with much Rain, and thus it blows about the Island of *Madagascar* and the adjacent Islands.

These storms are commonly preceeded by a great Sea out of the North. From *January* till *May* the Winds are at N.E. or N.N.E. fine fresh Gales and fair Weather. From *May* till *October* the Winds are Southerly, in *July, August,* and *September*, there are great Calms in the Bay of *Pate* and *Melende*, and a strong Current setting into the Bay: Therefore Ships that have occasion to pass this way in those three Months, ought to keep at least a hundred Leagues from the Coast to avoid being driven by the Current into the Bay; for these Calms do sometimes last six Weeks, yet off at Sea, at the distance of a hundred Leagues the Winds are fresh at South. At the Entrance into the *Red-Sea* near *Cape Guardefuer* there are commonly very hard Gales and turbulent Weather, even when the Calms are so great in the Bay of *Melende*, and not above ten or twelve Leagues at Sea from the said *Cape,* there is also very fair Weather, and pretty fresh Gales.

In the *Red-Sea* from *May* to *October*; the Winds are strong at S.W. and the Current setting out strong, so that there is no entering into that Sea in those Months, except you keep close to the South-shore, there you have Land-Winds, and an eddy Current. In the Months of *September* or *October*; the Wind shuffles about to the North, and at last settles at N.E. then comes fair Weather on this Coast; and so continues till the *Monsoon* shifts, which is in *April* or *May*; then it first takes one flurry at North, and from thence it veers to the East, and so about to the South, and there it settles.

The Account of this Coast from the *Cape of good Hope* hither, I had from Captain *Rogers*.

And as this hither-most part of the *East-Indies*, even from the *Cape of good Hope* to the *Red-Sea*, which Coast lies nearest N.E. and S.W. hath its shifting Seasons, so the other part of *India*, from the Gulph of *Persia* to *Cape Comorin*, has its constant Annual change, and from *Comorin* clear round the Bay of *Bengal*, the change is no less; and even from thence, through the *Streights of Malacca*, and Eastwards as far as *Japan*, the shifting Trade-Winds do alternately succeed each other as duly as the Year comes about.

It cannot be supposed that the Trade-Wind in all these Places, should be exactly on one Point of the Compass: For I have already shown, that these Trade-Winds on any Coast do commonly blow slanting in on the Shore about two or three Point; therefore in Bays where the Land lies on several Rombs, the Winds must alter accordingly. Though that Rule does not hold altogether true in Bays that are deep, but is chiefly meant for a pretty streight Coast, which lies near alike; allowing for Points of Land and small Coves which make no alteration: But on the sides and in the bottom of large Bays, such as the Bay of *Bengal*, the Bay of *Siam*, &c. the Wind differs much on one side of the Bay from what it does on the other; and both sides differ from the constant Trade on the open Coast; yet all shift in the shifting Season, which are *April* and *September*, at one and the same Time, to their opposite Points: I mean on the open Coast, for in some Bays there is a little alteration from that general Rule.

These shifting Winds in the *East-Indies*, are called *Monsoons*; one is called the East-*Monsoon*, the other the West-*Monsoon*. The East-*Monsoon* sets in about *September*, and blows till *April*; then ceaseth, and the West-*Monsoon* take place and blows till *September* again.

And both the East and West-*Monsoons* blow in their Seasons slanting in on the Coast, as is before described: The East-*Monsoon* brings fair Weather; the West brings Tornadoes and Rain. For (as I said before in the first Chap. of the General Trade-Wind at Sea) when the Sun comes to the North of the Line then all Places North of the Equator, within the Tropicks, are troubled with Clouds and Rain, but when the Sun is in Southern Signs then the Sky is clear. And as most of the Trading-Countries in the *East-Indies*, especially those on the Main Continent, do lye between the Line and the Tropick of *Cancer:* So these Countries are all subject to the Changes and Seasons already described. But the Islands lying under the Line, and to the South between the Line and the Tropick of *Capricorn*, have contrary Seasons to these. Yet do they change at the self-same Time.

The difference between the *Monsoons* on the North of the Line, and the *Monsoons* on the South of the Line is that in *April*, when the West-*Monsoon* sets in to the North of the Line, the S.S.W. Winds sets into the South of the Lat. and is called the S.S.W. *Monsoon* And in *September* when the East *Monsoon* sets into the North of the Line, the N.N.E. Wind blows in South Lat. and is called the N.N.E. *Monsoon*. And whereas the West-*Monsoon* is accompanied with Tornadoes and Rain in North Lat. the S.S.W. *Monsoon*, which blows at the same Time in South Lat. is accompanied with fair Weather. And as the East-*Monsoon* is attended with fair Weather in North Lat. the N.N.E. *Monsoon*, which blows at the same Time in South Lat. is attended with Tornadoes and very bad Weather. And though these Winds do not shift exactly at one Time in all Year; yet September and April are always accounted the turning Months, and do commonly participate of both sorts of Winds. For these *Monsoons* do as constantly shift by turns, as the Year comes about. And by means of this change of Winds, Ships have the benefit to sail from one part of India, with one Wind, and return with the contrary: So that most of the Navigation in India depends on the *Monsoons*. And Ships do constantly wait for these Changes; and the Merchants fit out to any Place according as the Season of the Year draws on: And wheresoever they go they certainly dispatch their Business so as to return back again with next or contrary *Monsoon*: For here is no sailing to and from any Place, but with the *Monsoon*: One carries them out, the other brings them back. Neither do I know how

it were possible for Merchants in these Parts to trade by Sea from one Country to another, were it not for these shifting *Monsoons*. For as I have said before, most of the trading Kingdoms in India do lye between the Line, and the Tropick of Cancer. And the Land lies so to the North, that Ships cannot go to the North of the Tropick, and by that means get into variable Winds way, as they may and do in the West-Indies, when they are bound far to the Eastward. Neither could it be any Advantage to stand off to Sea, as they may in the South-Sea; for that would be of little Moment, because they would then come so near the Line, that they would be always lyable to Tornadoes and Calms; and should they cross the Line and run to the Southward of it, thinking that way to gain their Passage, it is likely they might succeed no better there: For that part of the Sea which lies to the Southward of the Line is open and free to the true Trade, which seldom fails: But indeed that Wind would carry them to the Southward quite beyond the Trade into a variable Windsway. But the Sea is not open there, for Ships to pass so far to the Eastward as to gain their Ports.

For our East-India Ships that are bound to *Siam*, Tunqueen, *China* &c. cannot get thither but in the Season of the West-*Monsoon*, though they go directly from England; and though, after they are past the Cape, they have the convenience to stretch to the Eastward, as far as the Land will permit, yet they cannot go so far as is convenient before they will be obliged to steer down within the Course of the Trade-Winds, which would obstruct their Passage, if they were as constant here as in other Places. And therefore if these Anniversary *Monsoons* did not constantly succeed each other, Ships could not pass but one way; they might sail to the Westward, but there they must lye up, or be three or four Years in their return from a place which may be sailed in six Weeks, yet I say that to Places near each other, Ships may and do very often sail against the *Monsoon*, and that with success: For here are Sea and Land-Breezes under the shore, and in many Places good Anchoring, by which means Ships may stop when they cannot find the Current against them: But Voyages of a great distance cannot be made only with Land and Sea-Winds without some other helps.

In the West-Indies we have these helps of Land-winds and Sea-Breezes by which we sail from one Place to another, provided they are no great distance asunder, and perform our Voyages well enough; but when we are to sail a great way to the Eastward against the Trade-wind, then we are forced, as is said before, either to pass thro' the Gulph of Florida, if we are far to leeward, or else to pass between the Islands, and so stretch away to the Northward, till we are clear out of the Trade, and so get our Longitude that way. So in the South-Seas also, and on the Coast of Guinea, the Coast of Brazil, and the Coast of Africa, between the Cape of good Hope and the Red-Sea, there are Sea and Land-Breezes, which may be made use of to sail against the Trade, if the Voyages be short: But when we are to sail a great way against the Trade-wind, we must to wholly depend on the Sea and Land-Breezes; for then we should be a long Time in accomplishing such Voyages. In such Cases we have recourse to other helps, such as Providence has supplied these Seas with, which seems to be wanting in the East-Indies: as for example, in the South-Seas and on the Coast of Peru where the Southerly Winds blow constantly all the year, there Ships that are bound to the Southward stretch off to the Westward till they are out of the Coasting Trade-Wind, and there meet with the true Trade of E.S.E. with which they sail as far as they please to the Southward, and then steer in for their Port. So on the Coast of Mexico, where the Coasting Trade is westerly, there they run off to Sea, till they meet the true E.N.E. Trade; and then stretch away to the Northward, as far as their Port; and Ships that come from the Philipines, bound for the Coast of Mexico, stretch away to the North, as far as 40 Degrees, to get a Wind to bring them on the Coast.

Thus also all Ships bound to the East-Indies after they have past the Line in the Atlantick Ocean, stretch away to the Southward beyond the Trade, and then stand over to the Eastward, towards the Cape; so in returning home, after they have crost the Line to the Northward, they steer away North, with the Wind at E.N.E. till they are to the Northward of the Trade-Wind, and then

direct their Course Easterly. All Guinea Ships and West-India Ships do the same in their Returns; And this is the Benefit of an open Sea. But to return.

The *Monsoons* among the East-India Islands that lie to the Southward of the Line, as I said before, are either at N.N.E. or S.S.W. These also keep time, and shift, as the *Monsoons* do, to the North of the Line, in the Months of April and September, but near the Line, as a Degree or two on each side, the Winds are not so constant. Indeed there they are so very uncertain, that I cannot be particular so as to give any true Account of them: Only this I know, that Calms are very frequent there, as also Tornadoes and sudden Gusts; in which the Winds fly in a Moment quite round the Compass.

CHAPTER IV

OF SEA AND LAND-BREEZES

How Sea-Breezes differ from common Trade-Winds. The Time and Manner of their Rise; And particularly at Jamaica. Of the Land-Breezes. The Time and Manner of their Rise: As on the Isthmus of Darien and at Jamaica. The places where these Winds blow strongest or slackest; as at Capes and Head-Lands, deep Bays, Lagunes and Islands. Seal-Skin Bladders used instead of Bark-Logs.

Sea-Breezes, generally speaking, are no other than the common Trade-Wind of the Coasts on which they blow, with this difference, that whereas all Trade-Winds, whether they are those that I call the general Trade-Winds at Sea, or coasting Trade-Winds, either constant or shifting, do blow as well by Night as by Day, with an equal briskness, except when Tornadoes happen; so contrarily Sea-Winds are only in the Day, and case in the Night; and as all Trade-Winds blow constantly near to one Point of the Compass, both where the constant Trade-Winds are, or where they shift; on the contrary, these Sea-Winds do differ from them in this, that in the Morning when they first spring up, they blow commonly as the Trade-Winds on the Coast do, at or near the same Point of Compass; but about Mid-day they fly off two, three or four Points further from the Land, and so blow almost right in on the Coast, especially in fair Weather; for then the Sea-Breezes are truest; as for Instance, on the Coast of *Angola* the Land lies almost North and South, there the Trade-Wind is from the S.S.W. to the S.W. the true Sea-Breezes near the Shore are at W. by S. or W.S.W. and so of any other Coast.

These Sea-Breezes do commonly rise in the Morning about Nine-a-Clock, sometimes sooner, sometimes later: they first approach the Shore so gently, as if they were afraid to come near it, and oft-times they make some faint Breathings, and as if not willing to offend, they make a halt, and seem ready to retire. I have waited many a time both Ashore to receive the Pleasure, and at Sea to take the Benefit of it.

It comes in a fine, small, black Curle upon the Water, when as all the Sea between it and the Shore not yet reach'd by it, is as smooth and even as Glass in comparison; in half an Hour's time after it has reached the Shore it fans pretty briskly, and so increaseth gradually till Twelve-a-Clock, then it is commonly strongest, and lasts so till Two or Three a very brisk Gale; about Twelve at Noon it also veers off to Sea two or three Points, or more in very fair Weather. After Three-a-Clock it begins to die away again, and gradually withdraws its force till all is spent, and about Five-a-Clock, sooner or later, according as the Weather is, it is lull'd asleep, and comes no more till the next Morning.

These Winds are as constantly expected as the Day in their proper Latitudes, and seldom fail but in the wet Season. On all Coasts of the Main, whether in the *East* of *West-Indies*, or *Guinea*, they rise in the Morning, and withdraw towards the Evening, yet Capes and Head-Lands have the greatest Benefit of them, where they are highest, rise earlier, and blow later.

Bays contrarily have the Disadvantage, for there they blow but faintly at best, and their continuance is but short. Islands that lie nearest East and West, have the Benefit of these Winds on both sides equally; for if the Wind is at S.W. or S.W. and by S. on the South-side of any island, then on the North-side it would be at N.W. or N.W. by N. i.e. in fair Weather; but if turbulent Weather, it would be E.S.E. on the South-side and E.N.E. on the other: But this true Sea-Breeze does not veer so far out, except only near the Shore, as about three or four Leagues distant; for farther than that, you will find only the right Coasting Trade-Wind. This I have experienced in several Parts of the World, particularly at *Jamaica*; about which I have made many Voyages, both on the North and the South-side, where I have experienced the Sea-Breezes very much to differ; for on the South-side I have found the true Sea-Wind after Twelve a-Clock, and in very fair Weather at S. or S.S.E. though it spring up in the Morning at E.S.E. or S.E. And on the North-side I have found the Sea-Breeze at N. or N.N.E. though it rose in the Morning at E.N.E. but whether there may be the like difference about smaller Islands, as at *Barbadoes*, &c. I cannot determine, though I am apt to believe there is not. So much for the Sea-Winds, next of the Land-Breezes.

Land-Breezes are as remarkable as any Winds that I have yet treated of; they are quite contrary to the Sea-Breezes; for those blow right from the shore, but the Sea-Breeze right in upon the shore; and as the Sea-Breezes do blow in the Day and rest in the Night, so on the contrary, these do blow in the Night and rest in the Day, and so they do alternately succeed each other. For when the Sea-Breezes have performed their Offices of the Day, by breathing on their respective Coasts, they in the Evening do either withdraw from the Coast, or lie down to rest: then the Land-Winds, whose Office is to breathe in the Night, moved by the same Order of divine Impulse, do rouze out of their private Recesses, and gently fan the Air till the next Morning; and then their Task ends, and they leave the Stage.

There can be no proper time set when they do begin in the Evening, or when they retire in the Morning, for they do not keep to an Hour; but they commonly spring up between six and twelve in the Evening, and last till six, eight or ten in the Morning. they both come and go away again earlier or later, according to the Weather, the Season of the year, or some accidental Cause from the Land: For on some Coasts they do rise earlier, blow fresher, and remain later than on other Coasts, as I shall shew hereafter.

They are called Land-Winds, because they blow off shore contrary to the Sea-Breeze, which way soever the Coast lies: Yet I would not so be understood, as if these Winds are only found to breathe near the Shores of any Land, and not in the Inland Parts of such Countries remote from the Sea; for in my Travels I have found them in the very Heart of the Countries that I have passed through; as particularly on the Isthmus of Darien, and the Island of *Jamaica*: Both which Places I have travelled over from Sea to Sea; yet because these are but small Tracts of Land in comparison with the two main Bodies of Land of *Mexico* and *Peru*, and those vast Regions in *Asia* and *Africa* lying within the Tropicks, I cannot determine whether the Land-Winds are there, as I have found them in my small Travels: therefore I shall only confine this particular Discourse to these and other Places within my own Observations. I shall begin first with the Isthmus of *Darien*; there I have found the Land-Winds in the middle of the Country blowing all Night, and till ten or eleven a-Clock in the Morning, before I could perceive the Sea-Breeze to arise, and that not discernable many times, but by the flying of the Clouds, especially if I was in a Valley; and it was in the Vallies that I did chiefly perceive the Land-Winds, which blew in some Places one way, in others contrary, or side-ways to that according as the Vallies lay pent up between the Mountains; and that without any respect to either the North or the South-Seas, but indeed near either side of the Land, they always bent their Course towards the nearest Sea, unless there was any Hill between them and the Sea, and then they took their Course along in the Vallies; but from both Shores, as well from the

North as the South, they blow right-forth into the Sea.

In the Island of *Jamaica* these Land-winds are in the middle of the Country; also I have found them so, as I travelled from one side of the Island to the other, having lain two Nights by the way, as I had before observed them, when I liv'd at sixteen miles walk, where I continued about six Months; but there and in other Islands the Land-Winds do blow towards the nearest Shores, and so from thence off to Sea, whether the Shores lie East, West, North or South.

These Winds blow off to Sea, a greater or less Distance, according as the Coast lies more or less exposed to the Sea-winds: For in some Places we find them brisk three or four Leagues off shore; in other Places not so many Miles; and in some Places they scarce peep without the Rocks, or if they do sometimes in very fair Weather make a sally out a Mile or two, they are not lasting, but suddenly vanish away, though yet there are every Night as fresh Land-winds ashore at those Places as in any other Part of the World.

Places most remarkable for the fewest or faintest Land-winds, are those that lie most open to the Common Trade-winds, as the East-ends of any Islands where the Trade-winds do blow in upon the Shore, or the Head-Lands on Islands or Continents that are open to the Sea-Breeze, especially where the Trade-wind blows down side-ways by the Coast; for there such Head-Lands as stretch farthest out to Sea are most exposed to Winds from the Sea; and have the less Benefit of the Land-Breezes.

I shall give a few Instances of either. And first of all begin with the N.E. and S.E. Points of the Island of *Jamaica*: These Points are at the East-end of the Island, one is at the very Extreme of the North-side towards the East, the other on the South Extreme towards the same Points; at these two Places we seldom light of a Land-wind; nor very often at the End of the Island between them, except near the Shore. For that reason the *Sloop-men* of *Jamaica* that Trade round the Island are commonly put to their Trumps, when they come there in their Voyages: For if they meet no Land-wind, they are obliged to beat about by turning to Windward against the Sea-Breeze in the Day time; they then curse these Points of Land, and are foolishly apt to believe that some *Daemon* haunts there.

And if they are two or three Days in beating about (as sometimes they are) when they return to *Port-Royal*, they will talk as much of their Fatigues, as if they had been beating a Month to double the *Cape of Good Hope*, though indeed the Men are brisk enough, and manage their Sloops very well; which also are generally very good Boats to sail on a Wind. I think they are the best small Trading-Boats in the King's Dominions.

Point *Pedro* on the South-side of the Island, is another very bad Point to double, if a Ship come from the West-end of the Island; This Point runs out far into the Sea, and is not only destitute of the Common Land-winds. But if there is any Current setting to Leeward, here the Sloop-men meet it. Therefore they are many times longer beating about it, than about the two former Points of the South-East and the North-East, and not without bestowing some Curses upon it. Nay some Captains of Privateers, when they have been beating about it, have stood close into the Point, and fired their Guns to kill the old *Daemon* that they say inhabits there to disturb poor Seamen. I have related these off Passages to shew how ignorant Men are that cannot see the Reason of it. And because I am not willing to leave my Reader in the Dark, I shall give a few Instances more on this Subject. The North-side of *Jucatan*, at the Entrance into the Bay of *Campeachy*, gives us another Instance of bad Land-winds; and commonly where the Land-winds are scanty, the Sea-Breezes are but indifferent neither. This will partly appear by what I have observed of them on this Coast, between *Cape Catoach*, and *Cape Condecedo*, at the Entrance of the *Bay* of *Campeachy*, which two Places are about eighty Leagues distant; for there the Land trends East and West. It is a streight Coast, and lies all of it equally exposed to the Trade-wind, which is commonly there at E.N.E. To

the W. of the Places the Sea and Land-winds do as duly succeed each other, as on any other Coast, but here they are each of them of a Bastard Kind; for the Sea-Breezes are at N.E. by E. which is no better than a Coast Trade-wind, and the Land-Wind is at E.S.E. or S.E. by E. whereas if the Winds were as true there as on other Coasts, the Sea-Breeze would be at N.N.E. sometimes at N. and the Land-Winds would be at S.S.E. and S. as they are indeed close under th Shore; which if they do at any time come off from, they are very faint. The Land on this Coast is low and even, and the Land-Winds ashore are pretty brisk.

The Capes on the *Peruvian* Coast in the *South-Seas*, will more fully make it appear, that Head-Lands do seldom afford any Land-Winds. I shall only Instance in *Cape Passao*, in Lat. 8 minutes *South*, *Cape St. Laurence*, in Lat. 1 d. ———— *South*, and *Cape Blanco*, in 3 d. ———— *South*. I have pass'd by them all several Times and at different Seasons; yet did never find any Land-winds there, though between these Places there are very good Land-winds. Therefore Ships that sail to the Southward against the Breeze, must beat it about by hard Labour, especially about *Cape Blanco*, for that lies more exposed than the other two: and if there is any Current, as commonly, the *Spaniards* are a long Time getting about, sometimes a Fortnight or three Weeks; and when they have split their Sails, which are seldom very good, they run back to *Guiaquill* to mend them again. We found it hard getting about, tho' our Sails were good; and I think we could work our Ships better than the *Spaniards* are ever able to do in those Seas.

I have already given several Instances of such Places, as have no Land-Winds, or at least but very ordinary ones; I shall next proceed in order to shew where the strongest or best Land-winds are met with; and then I shall speak of those Places where there blows a moderate and indifferent Gale between both Extremes: That so any one may judge by the Lying of the Land, whether it may afford a good Land-wind or no.

The briskest Land-winds are commonly in deep Bays, in great Lakes within Land, and among great Ranges of Islands or small Keys that lye near the Shore: I shall give instances of all these. And as for Bays, I shall first pitch on the Bay of *Campeachy*, which lies between *Cape Condecedo* and the High-Land of St. *Martin*; between both these Places the Land-Winds are as brisk two or three Leagues off at *Sea*, as in any Places that I know. In the Cod or Middle of the Bay, the Land trends from East to West, there the *Sea-Breezes* are at North, and the Land-winds are South; they commonly begin to blow at Seven or eight a Clock in the Evening, and continue till eight or nine the next Morning, in the dry *Season* especially. In that Bay there is an Island, call'd by the *English Beef-Island* from the Multitude of Bulls and Cows that inhabit it. The Smell of these wild Cattle is driven off to Sea, by the Land-winds so fresh, that by it Masters of *Ships* sailing in the Night on this Coast have known where they were, and have presently anchored that Night, and come into the Island of *Trist* the next Day; whereas they would otherwise have past farther to the Westward quite out of their way, if they had not smell'd the strong Scent of these Cattle.

So all the Bottom of the Bay of *Mexico*, even from the High-Land of St. *Martin* down to *Lavera Cruz*, and from thence Northerly towards the River *Meschasipi* affords good Land-winds and Sea-breezes. The Bay of *Honduras* also, and almost all the Coast between it and *Cape La Vela*, affords the like, allowing for the Capes and Points of Land, which lye between, where if fails more or less, as the *Points* do lye more or less exposed to the Sea-Breezes.

So in the South-Seas, the Bays of *Panama, Guiaquil, Paita*, &c. have their fresh Land-winds and Sea-breezes. But in some Places, as particularly at *Paita*, the Land-winds do not spring up till twelve a Clock in the Night, but then are always very fresh, and last till seven or eight the next Morning; and they are constant all the Year long: Whereas in the Bay of *Panama*, and also in all the Bays and Coasts of the other, or North-side of *America* already described, they are not so constant in the wet *Season* as they are in the dry.

The Bay of *Campeachy* will also afford us Instances of the Land-winds that blow in *Lagunes*: As for Instance, the *Lagune* of *Trist*, which is about nine or ten Leagues long and three broad, is barricadoed from the Sea by the Island of *Trist*. There the Land-winds blow in the dry *Season* from five or six a Clock in the Evening, till nine or ten in the Morning. There are two other *Lagunes* lying within that, and parted from it by low *Mangrove-Land*: there the Land-winds are fresher and the Sea-Breeze duller, and of a less Continuance, than in the *Lagune* of *Trist*. Nay, sometimes the Land-wind blows all Day; so in the Lagune of Maracabo to Windward of *Cape Alta Vela*, the Land-winds are very fresh and lasting. The like may be said of the *Lagune* of *Venizuella* or *Comana*.

Sometimes in the fore-mentioned *Lagunes*, the Land-winds do blow for three or four Days and Nights together, scarce suffering the Sea-Breeze to breathe there; though at the same time the Sea-Breeze may blow fresh out at Sea: and if the Sea-Breeze at such time should make a bold *Sally* into these *Lagunes*, it would be but of a short Continuance. On the other Hand at Capes and Head-Lands more exposed to Sea-Breezes, the Land-winds are shyer of coming there, than the Sea-winds are into *Lagunes*. Neither may we forget the Harbour of *Jamaica*, for there are very good Land-winds. It is compassed in on one side with a long Neck of Sand, and many small Islands at the Mouth of it, and within there is a pretty deep Lake, in which are constant Sea and Land-winds, by which the Wherry-men run with full sail, both to *Legany* or *Passage Fort*, from the Town and back again. they go away with the Sea-Breeze, and return with the Land-wind. Therefore Passengers that have occasion to go either way, wait for the coming of these Winds, except their Business requires haste: for then they are rowed against the Breeze; and tho' the Land-winds do sometimes fail or come very late, yet the Wherries seldom stay beyond their constant Hours of seven or eight a Clock, and sometimes the Land-winds do come by three or four, but when they come so early it is commonly after a Tornado from the Land. This may suffice as to the Land-winds in Lakes or Bays.

As to what may be spoken concerning the Land-winds among Islands, I shall only mention two Places, both of them in the *West-Indies*; the first are the *Keys* of *Cuba*, which are Abundance of small Islands bordering on the South-side of *Cuba*, reaching in length from East to West, or near those Points as the Island lies, about seventy Leagues; and in some Places reaching near twenty Leagues from the said Island. Among these Islands, even from the outermost of them, quite home to *Cuba*, there are very brisk Land-winds. They spring up early in the Evening, and blow late in the Morning. The *Jamaica* Turtlers visit these *Keys* with good Success for Turtle all the Year long, and from thence bring most of their Turtle wherewith the Market of *Port-Royal* is served. The other Islands I shall mention are the *Sambaloe* Islands betwixt *Cape Samblass* and *Golden Island*, tho' they are not so large a Range as the *Keys* of *Cuba*, yet do they afford very good Land-winds; near as good as the *Keys* of *Cuba* do. And thus much for the Places where the best as well as where the scantiest or faintest Land-winds are found. I shall next give some Instances of the Medium between both Extremes.

I have already shewn that Capes and such Head-Lands as lye out farthest from the rest of the Shore, are thereby most exposed to the Sea-winds, and consequently the Land-winds are there much fainter than in other Places, especially in deep Bays or Lagunes within Land, or among Islands and small Keys near the Land: All which is no more than my own Experience has taught me. I shall now shew how the Land-winds blow on Coasts that do lye more level. As all Coasts have their Points and Bendings, so accordingly the Land-winds are fresher or fainter, as you come either towards these Bendings or towards intermitting Points or Head-Lands.

I shall give an Instance of this by shewing how the Winds are on the Coast of *Coraccos*. It is as streight a Shore as I can pitch on, yet full of small Bays, divided from each other by a like number of Ridges of Highland, that shoot forth their Heads a little way without the Bays on each side. There in the Night or Morning, while the Land-wind blows, we find fresh Gales out of the Bays:

but when we come abreast of the head-Lands, we find it calm; yet see the Breeze curling on the Water on both sides of us, and sometimes get a Spurt of it to help us forward: and having recovered the Wind out of the next Bay, we pass by the Mouth of it presently, till we come to the next Head; and there we lye becalmed as before.

These Bays are not above half a Mile or a Mile wide; neither are the Heads much wider; but these Heads of the Ridges lying in between the Bays, have steep Cliffs against the Sea; and whenever I have met the like steep Cliffs against the Sea, I have seldom found any Land-winds. But in all other Places where the Bays strike deeper into the Land, there we find the Land-winds more lasting and strong; and where the Points are farther out, there are still the less Land-winds, and the brisker Sea-Breezes. For the Capes and smaller Points on all Shores seem to be so many Barricadoes to break off the Violence of the Sea-Breezes; for this we always find when we are turning to Windward being to Leeward of a Cape, that the Breeze is moderate, especially if we keep very near the Shore; but when once we come within a Mile, more or less of the Cape and stand off to Sea, as soon as we get without it, we find such a hussing Breeze, that sometimes we are not able to ply against it, but in the Night we find a fresh Land-wind to Leeward; tho' when we come to the Cape we find it calm; or perhaps sometimes meet with a Sea-wind. The Land-Breezes on the Coast of *Guinea* between *Cape* St. *Anns* and *Cape Palmas*, (mentioned in the second Chapter of this Discourse,) are at E. blowing brisk four Leagues off Shore: the Sea-winds there are at S.W. The Land-winds on the Coast of *Angola* are at E.N.E., the Sea-winds at W.S.W. These are very true Winds of both kinds.

The Land-winds on the Coast of *Peru* and *Mexico* in the *South-Seas*, are in most Places right off from the Shore, else the Fisher-men could never go out to Sea, as they do, on Bark-Loggs. And as the Land-winds are true there, so are the Sea-Breezes also; for with the Land-wind they go out to fish, and return in again with the Sea-winds. In some Places they sue Seals-Skins instead of Bark-Loggs; they are made so tight that no Bladder is tighter. To these they have long Necks like the Neck of a Bladder, into which they put a Pipe and blow them up, as we do Bladders; two of these being fastned together, a Man sets astride them having one before and the other behind him; and so sits firmer than in a Trooper's Saddle. His Paddle is like a Quarter-staff, with a broad Blade at each end; with this he strikes the Sea back, first on one side, and then on the other, with each end of his Paddle, and so gives himself fresh way through the Water.

In the *East-Indies* also there are true Sea-Breezes, as well on the islands, as on the Main. On islands, as at *Bantam* in the Island *Java*, and at *Achin* in the Island *Sumatra*, and in many Places on the Island *Mindanao*: And on the Main also, as particularly at *Fort St. George* on the Coast *Coromandel*. There the Land-winds blow right off from the Sore, and the Sea-winds right in; but sometimes they come slanting in; and about *Christmas* they blow from the N.E. or N.N.E. I found them so when I came on the Coast, and being advised of it by Mr. *Coventry*, in whose Sloop I then was, I fell in with the Land ten or twelve Leagues to the Northward of the Fort, and had a brisk Northerly Sea-wind to bring me into the Road.

I think these Instances are enough to shew how these Land-winds do usually blow in most parts of the World; should I be very particular, 'tis not a larger Treatise then I intend this to be, would hold a quarter-part of it. But I have been more particular in the *West-Indies* and *South-Seas*, because these land-winds are of more use there than in the *East-Indies*: For though sometimes men in the East-Indies do turn against the *Monsoons*, yet they do generally tarry for them before they budge.

Indeed these Winds are an extraordinary Blessing to those that use the Sea in any Part of the World, within the Tropicks; for as the constant Trade-winds do blow, there could be no sailing in these Seas: But by the Help of the Sea and Land-Breezes, Ships will sail 2 or 300 Leagues; as par-

ticularly from *Jamaica*, to the *Lagune* of *Trist*, in the Bay of *Campeachy*; and then back again, all against the Trade-wind; And I think this one of the longest Voyages that is used of this kind. If any of our *Jamaica* Sloops do go to *Trist*, and design to carry their Wood to Crasao, then they put through the Gulph of *Florida*.

The *Spaniards* also that come from any part of the Bay of *Mexico*, and are bound to any Place to Windward of the Island *Cuba*, are wont to put through the Gulph, and so stretch away to the Northward, till they come clear of the Trade, and then stand away as far as they please to the Eastward; This is also the usual way from *Jamaica* to *Barbadoes*, though sometimes they turn up by the *Caribee* islands, only taking the Benefit of these Sea and Land-winds. So also Ships may and do pass from *Portobello* to *Carthagena*, or to St. *Martha*, or to any other Place, by the help of these Breezes, if the distance is not too far. So by taking the Advantage of these Winds, Sloops in the *West-Indies* sail clear round the Islands, or to any part of them, in a short time.

In the *South Seas* also the *Spaniards* in their Voyages from *Panama* to *Lima*, by taking the Advantage of these Winds, do sail as high as *Cape Blanco*; but in all their Voyages to the Southward of that Cape, they stand quite off to Sea into the Trade. Thus you see the Use and Advantage of them.

The Seamen that sail in Sloops or other small Vessels in the *West-Indies*, do know very well when they shall meet a brisk Land-wind, by the Fogs that hang over the Land before Night; for it is a certain sign of a good Land-wind, to see a thick Fog lye still and quiet, like Smoak over the Land, not stirring any way; and we look out for such Signs when we are plying to Windward. For if we see no Fog over the Land, the Land-wind will be but faint and short that Night. These Signs are to be observed chiefly in fair Weather: for in the wet Season Fogs do hang over the Land all the Day, and it may be neither Land-wind nor Sea-Breeze stirring. If in the Afternoon also in fair Weather, we see a Tornado over the Land, it commonly sends us forth a fresh Land-wind.

These Land-winds are very cold, and though the Sea-Breezes are always much stronger, yet these are colder by far. The Sea-Breezes indeed are very comfortable and refreshing; for the hottest Time in all the Day is about nine, ten, or eleven a Clock in the Morning, in the Interval between both Breezes: For then it is commonly calm, and then People pant for Breath, especially if it is late before the Sea-Breeze comes, but afterwards the Breeze allays the Heat. However, in the Evening again after the Sea-Breeze is spent, it is very hot till the Land-wind springs up, which is sometimes not till twelve a Clock or after.

For this Reason men when they go to Bed uncloath themselves and lye without any thing over them: Nay, the ordinary sort of People spread Mats at their Doors, or else in their Yards, in *Jamaica*, and lye down to sleep in the open Air.

In the *East-Indies* at *Fort* St. *George*, also Men take their Cotts or little Field-Beds, and put them into the yards, and go to sleep in the Air: And Seamen aboard Ships in these Hot Countries lye on the Deck, till the Land-wind comes.

The Inhabitants of *Jamaica* or *Fort* St. *George*, have somewhat to cover themselves when the Land-wind comes, beside a Pillow on their Breast, or between their Arms. But Seamen who have wrought hard all Day lye naked and exposed to the Air, it may be all Night long, before they awake, without any Covering, especially if they have had their Dose of Punch. But next Morning they are scarce able to budge, being stiff with cold that brings them to Fluxes, and that to their Graves; and this is the Fate of many stout and brave Seamen: and it is a great Pity that Masters of Ships have so little Regard for their men, as not by some good Orders, to prohibit this dangerous Custom of lying abroad and naked in the Nights.

CHAPTER V

OF LAND-WINDS AND SEA-BREEZES, PECULIAR TO SOME COASTS AT SOME PARTICULAR SEASON OF THE YEAR; AS ALSO OF SOME WINDS THAT PRODUCE STRANGE EFFECTS

Of the Summasenta-Winds *in the Bay of* Campeachy. *Of the Winds peculiar to the Coasts of* Carthegena. *Winds on the* Mexican *Coasts, call'd* Popogaios. *Others on the Coast of* Coromandel, *call'd* Terrenos*: the same about* Malabar, *but at a different Season: As also in the* Persian Gulph. *And of the* Harmatans *on the Coast of* Guinea.

I SHALL begin with the Summasenta-Winds[1], as they are called, which blow in the Bay of *Campeachy*. These are Winds that come in the Months of *February, March* and *April*, and they blow only in that Bay between the High-Land of St. *Martin* and *Cape Condecedo*; which Places are about 120 Leagues asunder. They are, properly speaking, neither Sea-Breezes nor true Land-winds, yet in Respect of their blowing in some Measure from the Shore, they are in that somewhat of kin to the Land-winds. These Winds are commonly at E.S.E. in the Cod or Middle of the Bay where the Land lies E. and W. and the true Land-Winds there are at S.S.E. but from thence towards *Cape Condecedo*, the Land trends away N.E. and N.N.E. and N. So that they become land-winds there respecting the Land from whence they blow; but then they differ both from Sea and Land-Breezes in Respct to their Duration: For these *Summasenta-Winds* blow three or four Days, sometimes a Week, both Night and Day before they cease. They are commonly dry Winds and blow very fresh, and Ships that go from *Trist* with Logwood at the Time when these Winds blow, will be at *Cape Condecedo* in three or four Days; whereas if the go at any other Time, it will take up eight or ten Days, tho' seldom more than that: For here are good Land-winds and Sea-Breezes at other times.

These Winds are commonly colder than the Sea-winds, though not so cold as the Land-winds, yet stronger than either. I never could perceive that these Winds did make any Alteration on our Bodies different from other Winds. But the Tides when these Winds blow on that Coast, are very small especially in the *Lagunes* of *Trist*: so that the Logwood-Barks that bring the Wood aboard of the Ships, are then forced to lye still for want of Water to float them over some Flats in the *Lagunes*.

On the Coast of *Carthagena* there are a peculiar sort of Winds that blow in the Months of *April, May* and *June* so very fierce, that Ships are not able to ply to Windward on that Coast while these Winds last. These Winds blow about forty or fifty Leagues to Windward of *Carthagena* Town, and about ten to leeward of it. They are very fierce from the Middle of the Channel between it and *Hispaniola*, and so continue almost to the Coast of *Carthagena*. Tho' they are sometimes a little fainter within two or three Leagues of the Shore, especially Mornings and Evenings. They commonly rise in the Morning before Day, sometimes at 3 or 4 a Clock, and so continue till 9, 10, 11 at Night, and thus they will blow 10 or 11 Days together very fiercely. At this Time the Land-winds besides their short Continuance are very faint and blow but a little way off Shore: So that from 10 or 11 at night till 3 in the Morning 'tis quite calm and not one Breath of Wind from a League distant off the Shore; tho' 3 or 4 further off you'll find the Breeze, and nearer a small land-wind. These Winds are at E.N.E. as the common Trade is; whereas the Sea-Breezes are at N.E. by N. or N.N.E.

While these fierce Winds stay, the Sky is commonly clear without any Cloud to be seen; tho' doubtless 'tis imperceptibly hazy, for then the Sun does not give a true black Shade on the Ground, but very faint and dusky. The Horizon too looks very dusky, thick and hazy, and while the Sun near

[1] See page 596

the Horizon, either in the Morning or Evening, it looks very red. Sometimes, tho' but seldom, when these Winds blow the Sky is overcast with small Clouds, which afford some drizling small Rain. But though these Winds are so fierce on the Coast of *Carthegena*, yet both to Windward and to Leeward at the distances before-mentioned, but Breezes keep their constant and regular Courses. Neither are the Coasts of *Hispaniola* or *Jamaica* troubled with these fierce Winds, any nearer than half Channel over as was said before.

It has not been my Fortune to have been on this Coast when these Winds have blown, yet I have had the Relations of it so often, and from so many Persons, that I am very well satisfied of the Trust of it: Nay, it is so generally known among the *Jamaica* Seamen and Privateers that they call a *Talkative Person* in Derision, a *Carthagene Breeze*. I remember two or three Men that went by that Name, and I knew them by no other, tho' I was in the same Ship with them several Months.

Some of our *English* Frigots that have been sent to *Jamaica* have experieinced these Breezes when the Governour has sent them upon Business to that Coast: For plying between *Portobello* and *Carthagena*, when they have been within 10 Leagues of *Carthagena*, they have met with the Sea-Breeze so strong that they have been forced to riff their Topsail, which even then they could not maintain, but have been obliged to furl it quite up; and so with only their lower Sails, which sometimes they have been forced to riff too, have been beating eight or ten Days, to get only so many Leagues; which tho' at last they have done, yet has it been with much Trouble, and not without Damage to their Sails and Rigging. Neither can I forget a *Squadron* of *French* Frigots, commanded by the Count *de Estrees*, that came to *Jamaica*, and demanded leave of the Governour to wood and water there; which because it seemed strange that they should want in coming only from *Petit Guavas*; it was demanded of them why they came from thence so ill provided? They said they went from *Petit Guavas* over to the Coast of *Carthagena*, with a Desgin to have plyed to Wind-ward under that Shore, but met the Breezes so hard on the Coast, that they were not able to hold up their sides against it, and for that Reason stood back again towards *Petit Guavas*; but not being able to fetch it, therefore they came to wood and water at *Jamaica*, designing to go from thence thro' the Gulph: And tho' the Pilots of *Jamaica* did all conclude that the Breeze-time was past by more than a Month, yet the Governour gave them leave to wood and water at *Blewfelds Bay*, and sent one Mr. *Stone* to be their Pilot thither. This was in 1679 and in one of our Summer Months, but I can't tell which, tho' I was there.

In the *South-Seas* on the *Mexican* Coast, between *Cape Blanco* in the Lat. of 9 D 56 M. North and *Realeja*, in Lat. 11 North, which two Places are about 80 Leagues Distance, there are Winds which blow only in the Months of *May, June* and *July*, call'd by the *Spaniards Popogaios*[2]. They blow Night and Day without Intermission, sometimes 3 or 4 Days or a Week together. They are very brisk Winds, but not violent: I have been in one of them when we went from *Caldera* Bay, bound to *Realeja* mentioned in my Voyage round the World, Cap. 5, Pag. 118, which blew at North.

In the *East-Indies* on the Coast of *Coromandel*, there are Winds call'd by the *Portuguese Terenos*[3], because they blow from the Land. These are not those Land-Winds that I have already treated of; for these blow only in *June, July* and *August*, and are in several respects quite contrary to them. For whereas the true Land-Winds blow only in the Night, including Evenings and Mornings; on the contrary, these blow 3 or 4 Days without intermission; nay sometimes a Week or 10 Days together; and as the true Nocturnal Land-Winds are very cold, on the contrary these are the hottest of all Winds I ever heard of: They come with hot Blooms, such as I have mentioned in my Voyage round the World, Cap. 20, Pag. 530 [XIX. 354]. These Winds are at West, and they blow only in the Months of *June, July* and *August*, which is the West *Monsoon-Season*, tho' the proper

[2, 3] See page 596

Monsoon then on this Coast is S.W. When these hot Winds come, the better sort of People at Fort St. *George* keep close: They also shut up their Windows and Doors to keep them out; and I have heard Gentlemen that lived there say, that when they have been thus shut up within Doors, they have been sensible when the Wind shifted by the Change they have felt in their Bodies. And notwithstanding that these Winds are so hot, yet the Inhabitants don't sweat while they last, for their Skins are hard and rough, as if they had been parched by the Fire, especially their Faces and Hands, yet does it not make them sick. The Sands which are raised by these Winds are a great annoyance to those whose business lyes abroad, and who can't keep their Houses. For many times they wheel about and raise the Sands so thick, that it flies like smoak in People Eyes; and the Ships also that lye in the road at that time have their Decks covered with this Sand.

On the Coast of *Malabar* they have of these sorts of Winds also, but not at the same time of the Year. For as these on the Coast of *Coromandel* blow in the Months of *June, July* and *August*, when the West *Monsoon* reigns; on the contrary on the *Malabar* Coast they blow in the Months of *December, January* and *February*, when the East or North-East *Monsoon* blows: for then the Easterly Wind, which is then the true *Monsoon*, comes from over the Land of this Coast; This being the West-side, as the Coast of *Coromandel* is the East-side of this long *East-Indian* Promontory.

The *Persian* Gulph is as remarkable for these hot Winds as either of the former; they come there in the Months of *June, July* and *August* in the West *Monsoon* time; and the heat there by all Accounts does by far exceed that on the other two Coasts.

The *European* Merchants that are imployed in the Ports within the King of Persia's Dominions, do leave their Coast, Habitations and Business there, during these hot Months, and spend their time at *Ispahan* till the Air is more agreeable to their Bodies; but their Servants must indure it. And if any Ships are there, then the Seamen also must do as well as they can. 'Tis reported the Commanders do keep Bathing-Troughs full of Water to lye and wallow in, and hide their Bodies from the noisom hot Blooms. I was never in any of these hot Winds, for I went from Fort St. *George* before they came on the Coast.

On the Coast of *Guinea* there are a particular Sort of Land-winds, which are very remarkable; not for their Heat, as those last-mentioned, but for their exceeding Cold and searching Nature. They are called *Harmatans*[4]. I have had an Account of them from several who have traded to *Guinea*; but more especially from a very sensible and experienced Gentleman, Mr. *Greenhill*, Commissioner of His Majesty's Navy at *Portsmouth*; who upon my Request, was pleased to send me the following Account: which the Reader cannot have better than in his own Words. Where, together with the *Harmatans*, he gives and Account also of all the Winds on that Coast.

Mr. Greenhill's Letter

SIR,

I have been very ill since my return Home with the Gout; so that I have not been capable of answering your Expectation: But being a little better recovered, I shall make as good a Return to your Enquiry of the Harmatans *on the Coast of Guinea, as my Circumstances will permit. The usual Time of their blowing is between the latter part of* December, *and the beginning of* February; *before and beyond which Season, they never exceed. They are of so very cold, sharp and piercing a Nature, that the Seams of the Floors of our Chambers and the Sides and Decks of our Ships (as far as they are above Water) will open so wide, as that with Facility you may put a Caulking-Iron a considerable way into them; in which Condition they continue so long as the* Harmatan *blows (which is sometimes two or three, and very rarely five Days, which is the very utmost I ever observed or heard of), and when they are gone, they close again and are as tight as if it never*

[4] See page 596

had been. The Natives themselves and all Persons who inhabit those parts (during that short Season) to prevent their pernicious Effects, are obliged to confine themselves within Doors; where they endeavour their own security, by rendering their Habitations as close and impenetrable as possible: Neither will they once stir abroad, unless induced thereto by a more than ordinary Occasion. It is as destructive to the Cattle also; whose safe Guard consists in their Proprietors Care, who against this Season ought to provide some such like place for them; Otherwise they must expect but a pitiful Account when the Season is over; for it most certainly destroys them, and that in a very short time.

This I accidentally experimented by exposing a couple of Goats to the Asperity thereof; which in four Hours Space or thereabouts, were depriv'd of Life. Nay we our selved (unless assisted by the like Conveniency and the benefit of some sweet Oyls to correct the Air) cannot fetch our Breath so freely as at other times; but are almost suffocated with too frequent and Acid Respirations. They generally blow between the E. and E.N.E. to the Northward of which they never exceed, being the most settled and steddy (but fresh) Gales I ever observed; coming without Thunder, Lightning or Rain; but close gloomy Weather; the Sun not shining all the Time: And when they expire, the Trade-wind (which constantly blows on that Coast at W.S.W. and S.W.) returns with the accustomary seasonableness of Weather.

The Coast of Africa *from* Cape Palmas *to* Cape Formosa, *lies E. and E. by N. and near those Points the Land Breezes blow on that Coast, which commonly begin about seven in the Evening, and continue all Night, till near that time the next Morning: During which interval, we are trouble with stinking Fogs and Mists off Shore, which by return of the Sea-Breezes upon the Opposite Points are all driven away; and we have the benefit of them, in a curious fresh Gale, till about* 5 *in the Afternoon.*

And here let me note it for a general Observation, That in these and all other Places within the Tropicks (as far as ever I took Notice) the Wind is drawn by the Land. For if an island or Head-Land, were inclining to a circular Form, the Sea and Land-Breezes fall in diametrically opposite to that part where you are. So that if you are on the South-side, the Sea-Breeze shall be at South, and the Land-Breeze (when it comes in its Season) at North.

In getting on the Coast, we indeavour to fall in with Cape Mount *or* Cape Miserada, *which is about 18 Leagues to the E.S. Eastward thereof; and after than we double* Cape Palmas *(whence as aforesaid, the Land trends away E. by N.) the Current near the shore sets upon that Point down into the* Bite. *But in getting off, we as much attempt (if possible) to lay hold of* St. Thomas; *and thence to run to the Southward of the* Line, *perhaps* 3 *or* 4 *Degrees; for the further Southerly we go, the stronger we find the Gales, and more beneficial for getting off the African Coast; but those who keep to the Northward thereof, generally meet with more Calms; and consequently longer Voyages ensue. In or about those Latitudes we continue, till we are got between* 25 *and* 30 *Degrees to the Westward of* Cape Lopez de Gonsalvo, *and then we cross again to go either for* England *or the* West-Indies. *But by the way let me observe to you, that when once we are to the Westward of the said* Cape, *and in South Latitude, the* Current *sets Northerly, and the Wind to* 20 *Degrees of Latitude, is at E.S.E. as (to the like number of Degrees) on the North-aide of the Line it blows at E.N.E. Neither did I ever observe any Mutation of the Currents, unless in the Tornado-Season, when during their blowing, the commonly set to Wind-ward; tho' perhaps the Moon upon Full and Change, may have the like Influence there, as in other Places; but I never took any particular notice thereof.*

The said Tornadoes *usually come in the Beginning of* April, *and seldom relinquish the* Gold Coast *till* July *commences, and with frequent Visits make us sensible of their Qualities. We have sometimes three or four in a day; but then their Continuance is but short; perhaps not above two Hours, and the Strength or Fury (it may be) about a quarter or half an Hour; but accompanied with prodigious Thunder, Lightning and Rain; and the Violence of the Wind so extraordinary, as that it has sometimes rolled up the Lead wherewith the Houses are cover'd, as close and compactly, as possible it could be done by the Art of Man. The Name implies a Variety of Winds: But the Strength of them is generally at S.E. and by Ships that are bound off the Coast, they are made use of to get to Windward.*

I shall conclude with that most worthy Observation of the Season wherein the Rains begin; which on the Gold Coast *is about the* 10th *of* April *and this may be generally remarked, from* 13 *d. N. to* 15 *d. South Latitude, that they follow the Sun within 5 or 6 d. And so proceed with him till he has touched the* Tropick, *and returns to the like Station again. This I shall illustrate by the following Example, viz.* Cape Corso *Castle*

lies in 4 *d.* 55 *North. About the* 10th *of* April *the Sun has near* 12 *degrees N. Declination. At that Time the Rains begin, and continue with the Inhabitants of that Place, untill he has performed his Course to the greatest Obliquity from off the Equator, and returned to the like Position South. The same I suppose may be observed, and understood of other Places within the* Tropicks.

The Variation *(of which in the Year* 1680, *I made frequent Observations) was 2 d. 14 m. Westerly: And it generally flows at the aforesaid place S.S.E. and N.N.W. upon the* Full *and* Change. *The Water rising upon Spring* Tides *about six or seven Foot up and down. I remain,*

SIR,
Your Humble Servant,
Henry Greenhill.

From his Majestry's Yard, near *Plymouth*,
June the 5th, 1698.

Upon the Receipt of this from the Gentlemen aforsaid, I wrote to him again, to have his Opinion about what I have said concerning the particular Latitude, in which 'tis best to cross the Line, in going from *Guinea* to the *West-Indies*; And so much of his Answer as concerns this Matter was in these Words.

MR. GREENHILL'S second Letter

SIR,

I do not dissent from Crossing the Line at 35 or 36 d. Longitude, Westward of Cape Lopes, *and it may as well be done at* 30 *provided the Breezes continue fresh. But if we have but little Winds, we generally run on the South-side of the* Line, *till we reach the distance West: And then crossing we steer away West North West, and West by North for* Barbadoes.

And this you may observe, (as I have already hinted to you), that the further we keep to the Southward of the Line, the fresher, and consequently more advantageous the Breezes are. I remain,

SIR,
Your obliged Friend,
And most humble Servant,
Henry Greenhill.

And here I judge it will not be unacceptable to the Reader to insert two other Letters from an Experienced Captain of a Ship, because they have a general Relation to the Subject I am now upon, as well as to the Coast of *Guinea* in particular.

Part of two Letters from Captain John Covant of Portbury,
to a Gentleman in London

LETTER I

Honoured SIR,

I have sent Mr. Dampier's *Book, which you were pleased to send me, to Captain S*_____ *I have gone through it, and find it very well worth my time, being very delightsome, and I believe true.*

I have made some Remarks on it, as having found the like of what he asserts, in other places. At p. 65 [53], *mention is made of the* Sucking-Fish, *or* Remora *(as* Mr. Dampier *calls it). These are mighty plenty on the Coast of* Angola *and at* Madagascar, *and between* Cape Lopes de Gonsalvas *and the* River Gabon. *They are shaped as he describes them.*

As to what he saith, p. 73 [58], *I have found the* Indians *in the Gulph of* Florida, *offering false* Ambergreece *to sale, and particularly in Lat.* 25 *d. where in the Year* 1693, *several of our* Men *were cheated with it.*

What Mr. Dampier *saith of the Laziness of the People of* Mindanao, p. 326 [223], *the very same may be said of the People of* Loango *on the Coast of* Guinea *exactly.*

Their manner of Worship, mentioned p. 338 [231], *is the very same with what I have seen at* Algier, *on the Coast of* Barbary.

The Nocturnal Dancings used by the Hottantotts *at the* Cape of good Hope *every Full and New Moon, p.* 541 [361], *are also practised by the Inhabitants of* Loango, Molinbo *and* Cabendo.

I shall give you the trouble of a small Relation of a Passage to Loango *in the Year* 1693. *When we came so far to the* Southward *as* 2 *d.* 40 *m. N. Lat. and* 8 *d.* 25 *m. Longi.* Westward *from the* Meridian *of* Lundi, *it being* 31*st of* March, *we had small Wind at S.S.W. and S.W. with showers of Rain. There we met with prodigious shoals of Fish, consisting chiefly of* Albicores *and* Bonetoes. *There were also a great number of Sharks; some 10 or 12 foot long. For diversion we catched above 100 of them at times. The other Fish we took as we had Occasion, fresh and fresh; and one day we caught a Barrel of them with empty Hooks. These shoals of Fish kept us Company till we were under the Equator in Long.* 4 *d* 3 *m. Eastward of the* Meridian *of* Lundy. *This was* April 27, *we had the Winds at S.E. and S.E. by E. fresh Gales and clear Weather, but a mighty Leeward Current. At the Fishes parting with us that Day, I caught an Albicore that weighed* 75 *l. It is a mighty strong Fish, so that the Fishing-Craft must be very strong to take them.*

The City *of* Loango *I find to lye in Lat.* 4 *d.* 30 *m. S. and Longi.* 18 *d.* 8 *m. Eastward from the* Meridian *of* Lundy*: from whence I took my departure, bound for* Jamaica, Oct. 7, 1693.

When we find the Winds South, S. by W. and S.S.W. fresh Gales; veerable to S.W. and back to South, we stand off to the Westward with Larboard Tacks on Board, till we get 14 *d. Long. to the Westward of* Loango. *And there we find the Winds veerable from S.S.E. to S.E. fresh Gales. When we get* 34 *d. to the Westward of* Loango, *we are then* 16 *d. Westward from the* Meridian *of* Lundy*: and there we find the Winds veerable from S.E. by E. to E. by S. and East: and so they continue to blow fresh as we will still run to the Westward between the Lat. of* 3 *and* 4 *d. South, till we make the Island* Fernande Noronho, *which I find to lye in Lat.* 3 *d.* 54 *m.* 30 *s. South. And by the Experience of two Voyages have found its Long.* 40 *d.* 59 *m. Westward from* Loango, *and* 22 *d.* 51 *m. from the* Meridian *of* Lundy. *This Island appears with a very high Pyramid. And when we come close to it, the Pyramid looks like a large Cathedral. On the N.W. side is a small Bay to anchor in. But Ships must come pretty near the Shore, because it is deep Water. Here is Plenty of Fish. And on the Island is some fresh Water, and low Shrubs of Trees. We could see no living Creature on it but Dogs. It was formerly inhabited by the* Portuguese, *but the* Dutch *having then War with them, took it, and carried the* Portuguese *all away. The Body of the Island I judge to be about* 4 *Miles long, lying N.E. and S.W. near on the North-side are some Rocks, pretty high above Water; and many Birds, as* Sea-Gulls *and* Man-of-War-Birds *(which are something like our* Kites *in* England*). I find the Current sets strong to the N.W. The Variation very little. From thence I steered N.W. with fresh Gales S.E. and at E.S.E. in order to cross the Equator, and designing to make the Island* Tobago*: which by my Run from the aforesaid Island, I find to lye in Lat.* 11 *d.* 33 *m. North Long. Westward of* Fernando, 28 *d.* 19 *m.* ⅗. *The Meridian distance from Fernando* 1721 *Miles* ⅘. *And by my Reckoning or Journal* Tobago *is West from the Meridian of the Isle of* Lundy 51 *d.* 10 *m.* ⅗. *In this Passage between the said Islands we find strange Ripling and Cockling Seas, ready to leap in upon the Ship's Deck; which makes us think the Current to be strong: And it seems to be occasioned by the great River on the main Land; which is not far from us in this Passage.* Tobago *is an high Island with a brave sandy Bay on the S.W. side, where the* Dutch *had formerly a great Fort, till molested by the* English *in the last* Dutch *War. From this Island I shaped my Course for* Jamaica, *and found the N.E. Corner to lye in Lat.* 18 *d. North; and in Long. West from* Tobago 13 *d. The* Meridian *distance from* Tobago *is* 749 *Miles West. In our passage we saw no Land or Island, till we made the N.E. end of* Jamaica*: which lyeth in Long. West from the* Meridian *of* Lundy 64 *d.* 10 *m. and West from the City of* Loango 82 *d.* 18 *m. I shall only add that I am of Opinion that the* Gallopagos *Islands do lye a great deal further to the Westward than our* Hydrographers *do place them, according as Mr.* Dampier *hints,* p. 100 [75] *of his* Voyage round the World.

I am,

SIR,

Your most humble Servant,

John Covant.

Portbury, Octob. 20, 1698

Part of a second *Letter* from Captain *Covant*; dated from *Bristol*, *Decemb.* 10, 1697

LETTER II

Sir,

Yours of the 6th Instant came to my Hands, with the inclosed Queries, which I shall endeavour to answer in part, as far as my memory will assist me, being now from home, and at a distance from my Journals, &c.

Answers to the Queries

1. *The common* Trade-Winds *on the Coast of* Angola, *blow from the S.W. to South, till about* 12 *d. Long. from the* Meridian *of the Isle of* Lundy.

2. *I have found them always in the same Quarter, and not subject to shift in all the Time I have used this Coast, except that at a small Distance off the Shore, they are sometimes a Point more to the Westward.*

3. *The* Dry Season *on this Coast I observed to be from the latter end of* April *to* September*; tho' sometimes intermix'd with some pleasant Showers of Rain. I cannot be so punctual as to the Time of the* Wet Seasons.

4. *The true* Sea-Breeze *I have commonly found here to be from W.S.W. to W. by S. if it be fair Weather: and the* Land-Breeze *is at E. by N. But if a* Tornado *happens, it causes the Winds to shift all round the Compass, and at last it settles at S.W. which is the former true* Trade-Wind.

I am yours

John Covant.

CHAPTER VI

OF STORMS

Storms less frequent, but more fierce between the Triopicks. Presages of their coming of Norths, the Times and Places where they blow: Signs of their Approach: N. Banks. A Chocolatta North. A North beneficial to Ships going from Campeachy *to* Jamaica. *A very uncommon way of wearing a Ship in a North. Of Souths, the Times and Places where they blow. A Description of a South at* Jamaica, *and at the Bay of* Campeachy*: Much Fish kill'd by that Storm. Of Hurricanes. A Description of a terrible one at* Antegoa, *where Abundance of Fish and Sea-Fowls were destroyed by it. The difference between North-Banks, and the Clouds before an Hurricane: the latter adorned with radiant Colours. Tuffoons in the* East-Indies *the same with Hurricanes in the* West. *Of Monsoons in the* East-Indies. *A storm called by the* Portuguese, *the* Elephanta, *which is the violentest Monsoon of that Season.*

Storms within the Tropicks are generally known to us by some Name or other, to distinguish them from other common Winds: and though Storms are not so frequent there, as they are in Latitudes nearer the Poles; yet are they nevertheless expected yearly in their proper Months; and when they do come, they blow exceeding fierce, though indeed some Years they do not come at all, or at least do not blow with that Fierceness as at other times. And as these Winds are commonly very fierce, so are they but of a short Continuance, in Comparison with Storms that we meet with in higher Latitudes.

In the *West-Indies* there are three sorts, viz. *Norths, Souths* and *Hurricanes*: In the *East-Indies* there are only two sorts, viz. *Monsoons* and *Tuffoons*[5].

[5] See page 597

All these sorts of violent Storms, except the Norths, are expected near one time of the Year: and this is taken notice of by those that have been in any of them; that they give certain Presages of their being at hand, several Hours before they come. Norths are violent Winds, that frequently blow in the *Bay* of *Mexico* from *October* till *March*: They are chiefly expected near the Full or Change of the Moon, all that Time of the Year, but they are most violent in *December* and *January*. These Winds are not confined to the Bay of *Mexico* only, but there they are most frequent, and Rage with the greatest Violence. They blow on the North-side of *Cuba* very fierce too, and in the Gulph of *Florida*; as also about *Hispaniola, Jamaica*, &c. and in the Channel between *Jamaica* and *Portabel*; and in all the *West-Indian* Sea between the Islands and the Main as high as the Island *Trinidado*. But from *Jamaica* Eastward, except on the North-side of the Island *Hispaniola*, they blow no harder than a pretty brisk Sea Wind. They are here at W.N.W. or N.W. though in the Bay of *Mexico* they blow strongest at N.N.W. and this is the Season of Westerly Winds in these East-parts of the *West-Indies*, as I have before noted in the third Chapter of this discourse. I shall be most particular of them that blow in the Bay of *Mexico*, and what Signs they give us beforehand.

Commonly before a North the Weather is very serene and fair, the Sky clear, and but little Wind, and that too veering from its proper Point, or the common Trade-Wind of the Coast; and breathing gently at S. at S.W. and West a Day or two before the North comes. the Sea also gives notice of a Storm, by an extraordinary and long Ebb. For a Day or two before a North, there will be hardly any discernable Flood, but a constant ebbing of the Sea. And the Sea-Fowls also before a Storm, do commonly hover over the Land, which they do not at other times use to do, in such great Flights and Numbers. All these Signs concurring, may give any Man notice of an approaching Storm, but the greatest and most remarkable Sign of a North, is a very black Cloud in the N.W. rising above the Horizon to about 10 to 12 degrees: the upper Edge of the Cloud appears very even and smooth, and when once the upper part of the Cloud is 6, 8, 10 or 12 degrees high, there it remains in that even form parallel to the Horizon without any Motion; and this sometimes 2 or 3 days before the Storm comes: At other times not above 12 or 14 Hours, but never less.

This Cloud lying so near the Horizon, is not seen but in the Mornings or Evenings, at least it does not appear so black as them; this is called by *English* Seamen a *North Bank*, and whenever we see such a Cloud in that part of the World, and in the Months before-mentioned, we certainly provide for a Storm; and tho' sometimes it may happen that such a Cloud may appear several Mornings and Evenings, and we may not feel the Effects of it, or but very little; yet we always provide against it; for a North never comes without such a foreboding Cloud. But if the Winds also whiffle about to the South, with fair flattering Weather, it never fails. While the Wind remains at S.S.W. or any thing to the South of the West, it blows very faint; but when once it comes to the North of the West, it begins to be brisk and veers about presently to the North-West, where it blows very hard; yet does it not stay there long before it veers to the N.N.W. and there it blows strongest and longest. Sometimes it continues 24 or even 48 Hours, and sometimes longer. When the Winds first comes to the N.W. if the black Cloud rises and comes away, it may chance to give but one Flurry, like that of a Tornado; and then the Sky grows clear again; and either the Winds continues at N.W. blowing only a brisk Gales, which the *Jamaica* Seamen call a *Chocolatta North*, or else it veers about again to the East, and settles there. But if when the Winds comes to the N.W. the Cloud still remains settles, the Wind then continues blowing very fierce even so long as the black Bank continues near the Horizon. it is commonly pretty dry and clear, but sometimes much Rain falls with a North: and tho' the Clouds which bring Rain, come from the N.W. and N.N.W. yet the black Bank near the Horizon seems not to move till the Heart of the Storm is broke. When the Wind starts from the N.N.W. to the N. 'tis a sign that the Violence of the Storm is past, especially if it veers to the East of the North; for then it soon flies about to the East, and there settles at its usual Point and

brings fair Weather: But if it goes back from the N. to the N.W. it will last a day or two longer, as fierce as before; and not without a great deal of Rain.

When our *Jamaica* Logwood-ships are coming loaden out of the Bay of *Campeachy* in the North-Season, they are glad to have a North. For a good North will bring them almost to *Jamaica*; neither have any of our Vessels miscarried in one of these Storms that I did ever hear of, though sometimes much shattered; but the *Spaniards* do commonly suffer by them, and there is seldom a Year but one or more of them are cast away in the Bay of *Campeachy* in this Season: for they don't work their Ships as we do ours. They always bring their Ships too under a Fore-sail and Mizen, but never under a Main-sail and Mizen, nor yet under the Mizen alone; but we generally bring too under Main-sail and Mizen; and if the Wind grows too fierce we bring her under a Mizen only; and if we cannot maintain that, then we balast our Mizen: which is by riffing and taking up great Part of the Sail. If after all this, the Winds and Seas are too high for us, then we put before it, but not before we have tried our utmost, especially if we are near a Lee-shore. On the contrary, the *Spaniards* in the *West-Indies* (as I said before) lye under a Fore-sail and Mizen: But this must needs be an extraordinary Strain to a Ship, especially if she be long. Indeed there is this Convenience in it, when they are minded to put away before it, 'tis but halling up the Mizen, and the Fore-sail veers the Ship presently: and I judge it is for that Reason they do it. For when the Wind comes on so fierce that they can no longer keep on a Wind, they put right afore it, and so continue till the Storm ceaseth, or the Land takes them up (i.e. till they are run a-shore). I knew two *Spaniards* did so, while I was in the Bay. One was a King's Ship, called the *Piscadore*. She run ashore on a sand Bay, a Mile to the West-ward of the River *Tobasco*. The other was come within four or five Leagues of the Shore, and the Storm ceasing, she escaped Shipwreck, but was taken by Captain *Hewet*, Commander of a Privateer, who was then in the Bay. Her Main-mast and Mizen were cut down in the Storm. Both these Ships came from *La Vera Cruz*, and were in the North-side of the Bay when first the Storms took them. And tho' we don't use this Method, yet we find means to wear our Ships as well as they; for if after the Mizen is hall'd up and furled, if then the Ship will not wear, we must do it with some Head-sail, which yet sometimes puts us to our Shifts. As I was once in a very violent storm, sailing from *Virginia*, mentioned in my *Voyage around the World*, we scudded before the Wind and Sea some time, wth only our bare Poles; and the Ship by the Mistake of him that con'd, broched too, and lay in the Trough of the Sea; which then went so high that every Wave threatned to overwhelm us. And indeed if any one of them had broke in upon our Deck, it might have foundred us. The Master, whose Fault this was, rav'd like a mad Man, and called for an Axe to cut the Mizen Shrouds, and turn the Mizen Mast over Board: which indeed might have been an Expedient to bring her to Course again. Capt. *Davis* was then Quarter-master, and a more experienced Seaman than the Master. He bid him hold his Hand a little, in hopes to bring her some other way to her Course: The Captain also was of his Mind. Now our Main-yard and Fore-yard were lowered down a Port-last, as we call it, that is, down pretty nigh the Deck, and the Wind blew so fierce that we did not dare to loose any Head-sail, for they must have blown away if we had, neither could all the Men in the Ship have furled them again; therefore we had no hopes of doing it that way. I was at this time on the Deck with some others of our Men; and among the rest one Mr. *John Smallbone*, who was the main Instrument at that Time of saving us all. Come! said he to me, let us go a little way up the Fore-shrouds, it may be that may make the Ship wear; for I have been doing it before now. he never tarried for an Answer, but run forward presently, and I followed him. We went up the Shrouds Half-mastup, and there we spread abroad the Flaps of our Coats, and presently the Ship wore. I think we did not stay there above three Minutes before we gain'd our Point and came down again, but in this time the Wind was got into our Main-sail, and had blown it loose; and tho' the Main-yard was down a Port-last, and our Men were got on the Yard as many as could lye

one by another, besides the Deck full of men, and all striving to furl that Sail, yet could we not do it, but were forced to cut it all along by the Head-rope, and so let it fall down on the Deck.

Having largely treated of Norths, I shall next give some Account of Souths.

South Winds are also very violent Winds. I have not heard any thing of these sorts of Storms, but at *Jamaica* or by *Jamaica* Sailors. The Time when they blow at *Jamaica* is about *June, July* or *August*, Months that Norths never blow in. The greatest Stress of Wind in these Storms is at South, from whence it's probable they are named *Souths*. In what they differ from the *Hurricanes* that rage among the *Caribbe Islands*, I know not, unless in this, that they are more constant to one Point of the Compass, or that they come sooner in the year than *Hurricanes* do, but those Storms call'd *Hurricanes*, had never been known at *Jamaica* when I was there. Yet since I have heard that they have felt the Fury of them several Times. But I was at *Jamaica* when there happened a violent South. It made great Havock in the Woods; and blew down many great Trees; but there was no great Damage done by it. *Port Royal* was in great Danger then of being washed away, for the Sea made a Breach clear through the Town; and if the Violence of Weather had continued but a few Hours longer, many of the Houses had been washed away: For the Point of Land on which that Town stands, is Sand; which began to wash away apace; but the Storm ceasing, there was no further Damage. This was in *July* or *August* in the Year 1674.

I was afterwards in the Bay of *Campeachy*, when we had a much more violent Storm than this, called also by the Logwood-Cutters a South. It happened some time in *June* 1676.

I was then cutting Logwood in the Western Creek of the West Lagune. Two days before this Storm began, the Wind Whiffled about to the South, and back again to the East, and blew very faintly. The Weather also was very fair, and the *Men-of-War-Birds* came hovering over the Land in great Numbers; which is very unusual for them to do. This made some of our Logwood-Cutters say, that we should have some Ships come hither in a short Time; for they believed it was a certain Token of the Arrival of Ships, when these Birds came thus hovering over the Land. And some of them said they had lived at *Barbadoes*, where it was generally taken Notice of: and that as many of these Birds as they saw hovering over the Town, so many Ships there were coming thither. And according to that Rule they foolishly guess'd there here were a great may Ships coming hither at that Time; tho' 'tis impossible that they could imagine there could be the hundredth part of the Ships arrive, that they saw Birds fly over their Heads. But that which I did most admire was, to see the Water keep ebbing for two Days together, without any Flood, till the Creek, where we lived, was almost dry. There was commonly at low Water seven or eight Foot Water; but now not above 3, even in the middle of the Creek.

About 4 a Clock the 2d Day after this unusual Ebb, the Sky looked very black, and the Wind sprung up fresh at S.E. and increasing. In less than two Hours time it blew down all our Huts, but one; and that with much Labour we propt up with Posts, and with Ropes case over the Ridge, and fastning both ends to stumps of Trees, we secured the Roof from flying away. In it we huddled all together till the Storm ceased. It rained very hard the greatest part of the Storm, and about two Hours after the Winds first sprang up, the Waters flowed very fast in. The next Morning it was as high as the Banks of the Creek: which was higher than I had ever seen it before.

The Flood still increased, and run faster up the Creek than ever I saw it do in the greatest Spring-Tide; which was somewhat strange, because the Wind was at South, which is right off the Shore on this Coast. Neither did the Rain any thing abate, and by ten a Clock in the Morning the Banks of the Creek were all overflown. About twelve at Noon we brought our Canoa to the side of our Hut, and fastned it to the Stump of a Tree that stood by it; that being the only Refuge that we could now expect; for the Land a little way within the Banks of the Creek is much lower than where

we were: So that there was no walking through the Woods because of the Water. Besides, the Trees were torn up by the Roots, and tumbled down so strangely across each other, that it was almost impossible to pass through them.

The Storm continued all this Day and the Night following till ten a Clock: then it began to abate, and by two in the Morning it was quite calm.

This Storm made very strange work in the Woods by tearing up the Trees by the Roots: The Ships also riding at *Trist* and at *One-Bush-Key*, felt the Fury of it to their Sorrow; for of four that were riding at *One-Bush-Key*, three were driven away from their Anchors, one of which was blown into the Woods of *Beef-Island*. And of the four Ships that were at *Trist*, three also were driven from their Anchors, one of which was cast up about twenty Paces beyond High-Water-mark on the Island of *Trist*. The other two were driven off to Sea; and one of them was never heard of since.

The poor Fish also suffered extremely by this Storm, for we saw Multitudes of them either cast on the Shore, or floating dead on the Lagunes. Yet this Storm did not reach 30 Leagues to Windward of *Trist*, for Captain *Bally* of *Jamaica*, went hence but three Days before the Storm began, and was not past 30 Leagues off when we had it so fierce, yet he felt none of it; but only saw very black dismal Clouds to the Westward, as he reported at his Return from *Jamaica* to *Trist* four Months after.

I shall speak next of *Hurricanes*[6].

These are violent Storms, raging chiefly among the *Caribbee Islands*; though, by Relation, *Jamaica* has of late been much annoyed by them; but it has been since the Time of my being there. They are expected in *July, August*, or *September*.

These Storms also as well as the Norths or Souths, give some Signs of their Approach before they come on. I have not been in any one of them my self, but have made enquiry of many Men that have, and they all agree that either they are preceded by flattering unusual small Winds and very fair Weather, or by a great Glut of Rain, or else by both Rains and Calms together.

I shall give an Instance of one that gave such Warning. It happened at *Antegoa* in August 1681. I had the Relation of it from Mr. *John Smallbone*, before-mentioned, who was Gunner of a Ship of 120 Tons and 10 Guns, commanded by Capt. *Gadbury*.

Before this Storm it rained two Days excessively, then it held up two or three Days more: but the Sky was clouded and appear'd to be much troubled, yet but little Wind. the Planters by this were certain of a Hurricane, and warned the Ship-Commanders to provide for it, expecially Capt. *Gadbury*; who had careen'd his Ship in *Muskito Cove* in St. *John's* Harbour but a little before, and by this Warning given him by the Planters, had gotten his Goods on Board again, which though all he had, yet was but about half his lading of Sugar, Molosses and Rum. He also moored his Ship as secure as he could, with all his Cables and Anchors, besides some Cables which he had made fast ashore to great Trees. And about 7 a Clock that Evening that the Storm came, he dreading it, went ashore with all his Men, and retired into a poor Planter's House about half a Mile from the Shore. By that time he and his Men were arrived at the House, which was before 8 a Clock; the Wind came on very fierce at N.E. and veering about to the N. and N.W. settled there, bringing with it very violent Rains. This it continued about four Hours, and then fell flat calm, and the Rain ceased.

In this Calm he sent 3 or 4 of his Men down to the *Cove* to see what Condition the Ship was in, and they found her driven ashore dry on the Sand, lying on one side, with the Head of her Mast sticking into the Sand; after they had walk'd round her and view'd her a-while, they return'd again to the Capt. to give him an Account of the Disaster, and made as much haste as they could, because the Wind began to blow hard at S.W. and it blew so violently before they recover'd the House, that the Boughs of the Trees whipt them sufficiently before they got thither; and it rained as hard as

[6] See page 597

before. The little House could carce shelter them from the wet; for there was little beside the Walls standing: For the 1st Northerly Gust blew away great part of the Ridge and most of the Thatch. Yet there they staid till the next Morning, and then coming to the Ship found her almost upright; but all the Goods that were in the Hold were wash'd out, and the Sugar was wash'd out of the Cask. Some of the Run they found; a Cask in one place and a Cask in another: some on the Shore, and some half a Mile in the Woods; and some stay'd against the Trees and leek'd out; for it seems there had been a violent Motion in the Sea, as well as in the air. For in the Beginning of the Night when the N.E. Gust raged, the Sea ebb'd so prodigiously, or else was driven off the Shore by the Violence of the Wind so far, that some Ships riding in the Harbour in 3 or 4 Fathom Water, were a-ground, and lay so till the S.W. Gust came, and then the Sea came rowling in again with such prodigious Fury, that it not only set them a-float, but dash'd many of them on the Shore. One of them was carried up a great way into the Woods: another was strangely hurl'd on two Rocks that stood close by one another; with her Head resting on one Rock, and her Stern on the other: and thus she lay like a Bridge between the two Rocks, about ten or eleven Foot above the Sea, even in the highest Tides; for the Tides do usually rise here but little, not above two or three Foot, but in these Hurricanes it always ebbs and flows again prodigiously.

It was not the Ships only that felt the Fury of this Storm, but the whole Island suffered by it; for the Houses were blown down, the Trees tore up by the Roots, or had their Heads and Limbs sadly shattered, neither was there any Leaves, Herbs or green Thing left on the Island, but all look'd like Winter. Insomuch that a Ship coming thither a little after, that used that Trade, could scarce believe it to be the same Island. Neither did the Fury of this Storm light only here for *Nevis* and St. *Christopher's* had their Shares also; but *Mountsurant* felt little of it, tho' not above a Fortnight after there happened another Storm, as violent as this, and raged extremely there, but did little Damage to *Nevis* and St. *Christopher's*. *Antegoa* had a great Share of this too. Capt. *Gadbury's* Ship, that lay a-ground before it came, was by it hurled over to the opposite part of the Harbour, and there thrown dry on the Sand.

The Day after the Storm, the Shore was strew'd with Fish of divers sorts, as well great as small; such as Porpoises, Sharks, &c. and Abundance of Sea-Fowls also were destroyed by it.

I would not have any Man think that these Hurricanes, or any other Storms, do always give warning of their coming exactly alike: For there may be some Difference in those Signs, tho' all of them be plan enough if well observed. Besides sometimes they are duplicated, sometimes only single Signs, and sometimes the Signs may be more visible and plain than at other Times: when by some accidental Cause those Signs may be less visible by Reason of some high Hill or Mountain that may be interpos'd between you and the Horizon, especially if any Hill lies N.E. from you, which is the Quarter that Hurricanes do commonly rise in.

The Clouds that precede a Hurricane are different from the North-Banks, in this, that whereas the Clouds preceding Norths are uniform and regular; of any exact Blackness even from the Horizon to the upper Edge of it, and that as streight and even as a Line stretched out. On the contrary, the Hurricane-Clouds tower up their Heads, pressing forwards as if they all strove for Precedency; yet so linked one within another, that all move alike. Besides, the Edges of these Clouds are gilded with various and afrighting Colours, the very Edge of all seems to be of a pale fire-colour, next that of a dull yellow, and nearer the Body of the Cloud of a Copper-Colour, and the Body of the Cloud which is very thick appears extraordinary black: and altogether it looks very terrible and amazing even beyond Expression. Tho' I have never been in any Hurricane I the *West-Indies*, yet I have seen the very Image of them in the *East-Indies*, and the Effects have been the very same; and for my part I know no Difference between a Hurricane among the *Caribbee-Islands* in the *West-Indies*, and a Tuffoon on the Coast of *China* in the *East-Indies*, but only the Name: And

I am apt to believe that both Words have one Signification, which is, a *violent Storm*[7].

I have given a large Account of one of these in my *Voyage round the World;* Chapter XV, Page 414 [280,281], that gave warning by flattering Weather beforehand, and a very dismal Cloud, set out with such Colours as I have before described, rising in the N.E. from whence the Violence of the first Gust came, which was wonderful fierce and accompanied with extraordinary hard Rain; then it afterwards fell calm about an Hour, and then the Wind came about at S.W. and blew as fierce as it did before at N.E. which is much like the Hurricane before-mentioned at *Antegoa,* but of a longer Continuance than that: Besides, in both places they blow at one time of the Year, which is in *July, August* or *September;* and commonly near the Full or Change of the Moon.

Another thing that we must also take notice of, is, that both Places are North of the Equator, though not exactly in one Latitude.

But of these Tuffoons I shall say no more now, having described them particularly in my Voyage to *Tonquin,* Chap. II. Pag. 36 [31].

The Monsoons in the *East-Indies* are the next to be treated of; by which I do not mean the Coasting Trade-wind, so called, which I have already described in *Page* 21 [239,240] of this Discourse; for though [*Monsoon*] is a general Word for the Wind there, distinguished by East or West, according to the Points from whence they blow; yet it sometimes also signifies a *Storm,* as I now take it. And it is easie to be understood, when it is used in Reference to the Trade-wind, or when spoken of a Storm; for if applied to a Storm, 'tis express'd by some Epithet going before: As Violent, Terrible, &c. without any Distinction of East or West, which is commonly used in speaking of the Trade-Wind.

These Monsoons or Storms on the Coast of *Coromandel* are expected either about *April* or *September,* which are accounted the two shifting Months. For in these two Months the Winds begin to shift and turn from that Point, on which they have blown several Months before to the contrary Points of the Compass; as from East to West, or the contrary: but commonly this Shift is attended with a turbulent Sky, which ends in a violent Storm of Wind, or excessive Rains, or both: And this is called also the breaking up of the *Monsoon.* It was in one of these that I past from *Nicobar* to *Sumatra,* mentioned in my *Voyage round the World,* Chap. XVIII. Page 496 [332]. This was the *April Monsoon.*[8]

The *September* Monsoons are generally more violent than these last: yet by the Account I have lately had from Fort St. *George,* they have suffered very much by one of the *April* Monsoons (if it may be so called) for it came before its usual time, even before it could be expected.

As for the *September* Monsoons, tho' the time of the Year is so well known, and the Warnings of their Approach almost certain; yet our East-India Merchants have had very considerable Losses there; for the Stress of the Winds blows right in upon the Shore, and often hurries the Ships from their Anchors, and tosses them in a l\10ment on the sandy Bay.

Indeed the want of a secure Place to ride in, is the greatest Inconvenience of that Factory, a Place doubtless designed by the *English* from its Original to be the Center of the Trade of these Parts. For all our Factories, and the Trade in general, East from Cape *Comorin,* are now subordinate to this.

The *Dutch* had once a place of Consequence, called *Pallacat,* on this Coast, about twenty Leagues to the North of it; but they withdrew most of their Families and Effects from thence in the Year 1691, mentioned in my *Voyage round the World,* Chap. XX, Page 522 [XIX. 349]. And it is very probable that these rageing Winds might be one Cause of this their deserting it, whatever was

[7] See page 507

[8] See page 597

the Motive of settling here; for they have secure Harbours, and Roads enough in *India*, which we to our great Disadvantage very much want.

But to return to the Monsoons.

These (as I have told you) blow fiercest in *September*, and, as I have been informed, blow on several Points of the Compass.

The stormy Monsoons on the *Mallabar* Coast differ from these on the Coast of *Coromandel*, in that they are more common, and last even from *April* to *September*, which is as long as the common West-*Monsoon* lasts, though not so frequent and lasting in the Beginning of the Monsoon, as towards the latter end.

The Months of *July* and *August* afford very bad Weather, for then there is hardly any Intermission, but a continued troubled Sky full of black Clouds which pour down excessive Rains, and often very fierce Winds. But towards the breaking up of the *Monsoon*, they have one very terrible Storm called by the *Portuguese* the *Eliphanta*, which concludes the bad Weather. For after that they put to Sea without fear of any more Storms that Season.[9]

These violent Winds blow directly in upon the Shore; and they dam up the Harbours on this Coast, especially that of *Goa*, so that no Ships can go in or come out then; but after the violent Winds are past, the Channel opens again, and so continues till the next Season.

This Relation I had from a very ingenious Gentleman who was at *Goa* during the bad Weather.

I shall only take notice that these Storms are also at the same Time of the Year, when the Hurricanes and Souths are in the *West-Indies*, and the Tuffoons on the Coasts of *China*, *Tunqueen*, *Cochinchina* and *Cambodia* in the Eastern Parts of the *East-Indies*, and that all these Places are to the North of the Equator.

CHAPTER VII

OF THE SEASONS OF THE YEAR

The Wet and Dry Seasons on the North-side of the Equator; and on the South of it. Places famous for much dry Weather; as part of Peru, *and* Africa. *A Comparison between those Coasts. Of raining Coasts; as* Guinea. *Why* Guinea *more subject to Rains than the opposite Coast of* Brazil. *The time of Sugar-making. Of the Seasons at* Suranam. *Bays more subject to Rain than Head Lands. Several Instances of this, as at* Campeachy, Panama, Tunqueen, Bengala, *&c. Mountains more subject to Rains than Low Land: An Instance of this at* Jamaica. *The Isle of* Pines *near* Cuba, *a wet Place. So is also* Gorgonia *in the* South-Seas. *The manner how Tornadoes arise.*

As Summer and Winter are the two most different Seasons in our Climate; so the *Dry* and the *Wet* are within the Torrid Zone; and are always opposite to each other. They are often called by *Europeans Winter* and *Summer*, but more generally, *Dry* and *Wet*.

The Seasons on each side of the Equator, are as different as the Seasons of Summer and Winter are in temperate Climates, or near each Pole. For as 'tis Summer near the North-Pole, when 'tis Winter near the South Pole, and the contrary; so when 'tis fair and dry Weather North of the Equator, 'tis blustering and rainy Weather South of it; and the contrary, except within a few degrees of the Line, and that in some places only.

There is also this difference between the Torrid and Temperate Zones, either North or South of the Equator; that when it is fair and dry Weather in the one, it is Winter in the other: and when it is wet in the one, it is Summer in the other. I speak now of Places lying on the same side of the Equator: For as the Sun when it passes the Equinox, and draws towards either of the Tropicks,

[9] See page 597

begins to warm their respective Poles, and by how much the nearer he approaches, by so much is the Air without the Tropicks clear, dry and hot; on the contrary, within the *Torrid Zone* (though on the same side of the Line) the farther the Sun is off, the dryer is the Weather. And as the Sun comes nearer, the Sky grows more cloudy and the Weather more moist: for the Rains follow the Sun, and begin on either side of the Equator, within a little while after the Sun has crost the Equinox, and so continue till after his return back again.

The wet Season on the North-side of the Equator in the *Torrid Zone*, begins in *April* or *May*, and so continues till *September* or *October*.

The dry Weather comes in *November* or *December*, and continues till *April* or *May*.

In South Latitudes the Weather changes at the same times, but with this difference, that the dry Months in South Latitude, are wet Months in North Latitude, and the contrary, as I have said before. Yet neither do the wet or dry Seasons set in or go out exactly at one time, in all Years; neither are all places subject to wet or dry Weather alike. For in some places it rains less than in others; and consequently there is more dry Weather. But generally Places that lye under the Line, or near it, have their greatest Rains in *March* and *September*.

Head-Lands or Coasts that lye most exposed to the Trade-winds have commonly the best share of dry Weather. On the contrary, deep Bays or Bendings of the Land, especially such as lye near the Line, are most subject to Rains. Yet even among Bays or Bendings, there is a great deal of difference in the Weather as to dry or wet; for the Weather, as well as the Winds seem to be much influenced by accidental Causes; and those Causes themselves, whatever they are, seem to be subject to great variation.

But to proceed with Matter of Fact; I shall begin with the driest Coasts; and first with that of *Peru*, from 3 d. South to 30 d. South. There it never Rains, neither at Sea for a good distance off shore, as for 250 or 300 Leagues; no nor on the shore for a considerable way within Land; though exactly how far I know not; yet there are small Mists sometimes in a Morning for two or three Hours, but seldom continuing after 10 a-Clock; and there are Dews also in the Night.

This Coast lies N. and S. it has the Sea open to the West, and a Chain of very high Mountains running along shore on the East, and the Winds constantly Southerly, as I said before in the second Chapter of Winds.

In which Head I have made a Comparison as well of the Winds on the Coast of *Africa* in the same Latitude, as of the lying of the Coasts. Only there is this difference, that the coasting Trade-winds on the *American* side do blow further from the Land than those on the *African* side. Which difference may probably arise from the disproportion of the Mountains that are in the two Continents; for 'tis known that the *Andes* in *America* are some of the highest Mountains in the World, but whether there are any on the Continent of *Africa* in those Latitude so high, I know not, have not heard of any, at least none such are visible to Seamen.

I come now to speak of the Weather on the *African* Coast, which though 'tis not so dry as the Coast of *Peru*, yet is it the next to it. The Weather there is very dry from *March* till *October*, which is the dry Season.

The rainy Season, which is from *October* till *March*, is moderate, without that excess that is in most other Places in those Latitudes; so that the wettest Season can only be called so from some gentle showers of Rain.

There are some Tornadoes, but not so many as are in any other Places, both of the East or *West-Indies*, the *Peruvian* Coast excepted. And if the height of the *Andes* are the cause that the true East-Breeze does not take place in the Pacifick-Sea, within 200 Leagues distance from the shore, when yet the Trade blows within 40 Leagues of the *African* Coast; that Coast may perhaps be supposed to want such high Mountains. And if those *American* Mountains do stop the Winds from their

Career, why may they not as well break the Clouds before they reach near the shore, and be the cause of the dry Weather there? And seeing both Coasts do lye alike, and the Wind is alike; why should not the Weather be the same; were it not for the disproportion between the Mountains of these Coasts? For the East-side of those Mountains are supplied with Rain enough, as may be known by the great Rivers that disembogue from thence into the Atlantick Sea; whereas the Rivers on the *South-Sea* Coast are but very few and small; some of which do wholly dry away for a good part of the Year; but yet they constantly break out again in their Seasons, when the Rains in the Country do come, which always fall on the Westside of those Mountains, and this is about *February*.

As I have spoken before of dry Coasts, so now I shall speak of rainy ones. I shall begin with the Coast of *Guinea*, from Cape *Lopos*, which lies one degree South, taking in the Bite or Bending of the Land, and all the Coast West from thence, as far as Cape *Palmas*.

This is a very wet Coast, subject to violent Tornadoes and excessive Rains, especially in *July* and *August*: In those Months there is scarce any fair Day. This Coast lies all of it very near the Equator, and no where above 6 or 7 degrees Distance; so that from its nearness to the Equator only, we might probably conjecture that it is a rainy Coast; for most places lying near the Line are very subject to Rains: yet some more than others; and *Guinea* may be reckoned among the wettest Places in the World. There may be Places where the Rains continue longer, but none are more violent while they last.

And as its nearness to the Line may be a great cause of its Moisture; so by its situation also one would guess that it should be subject to a great deal of Rain; because there is a great Bite or Bending in of the Land, a little to the North of the Line; and from thence the Land stretcheth West parallel with the Line. And these Circumstances singly taken, according to my Observations do seldom fail, but more especially where they both meet. Yet there may be other causes that may hinder those Effects, or at least serve to allay the violence of them, as they do on some other Coasts. I shall only instance in the opposite Coast of *America* between the North Cape, which lies North of the Equator, and Cape *Blanco* on *Brazil*, in South Latitude. Now this Land lies much after the Form of the Coast of *Guinea*, with this difference, that one Coast lies in South Lat. the other lies North of the Equator, both of these Promontories lay parallel with the Equator, and there's not much difference in their distance from it; but that which makes the difference is, that one juts out Westward, the other Eastward; and so one is the very Westermost Land of the Continent of *Africa*, the other is the Eastermost Land of the Continent of *America*: The one has only an eddy Wind, which seems to me to be the Effect of two contrary Winds: The other Coast lies open to the Trade, and never wants a Breeze. And the former is troubled with Tornadoes and violent Rains during the wet Season, which is *May, June, July, August* and *September*: But the extremest wet Months are July and August; when it rains in a manner continually. *April* and *October* also sometimes are wet Months.

The other Coast on the *American* Continent, which lies open to the E. and N.E. or S.E. and which enjoys the freer Trade-Wind, is less subject to Rain; only as it lies near the Line, it has its part, but not to Excess, nor in any Comparison with *Guinea*. And as the Line is to the N. of it, so its wet Months are from *October* till *April*, and the dry Season from *April* to *October*. And these Seasons reach even to six or seven Degrees North of the Line: Which I do not know to be so in any other part of the World again. Indeed Cape *Lopes* in *Guinea*, is in one degree South, yet participates of the same Weather that the rest of *Guinea* has, which lies to the North of the Line.

Now the Reason why *Europeans* do account the dry Season Summer, and the wet Season Winter, is because the dry Season is their Harvest time, especially in our Plantations, where we chiefly make Sugar; for then the Canes are as yellow as Gold. They have then indeed less Juice,

but that little there is, is very sweet. Whereas in the wet Season, tho' the Canes are ripe, and come to their Maturity; yet do they not yield such Quantities of Sugar, neither is it so good, tho' the Pains in boiling it be also greater. Therefore in Northern Climates, as all our Plantations are in they commonly begin to work about making of Sugar at *Christmas*; after the dry Season has brought the Canes to a good Perfection. But in South Climates, as on the Coast of *Brazil*, they begin to work in *July*. Some Places there are in the North Latitudes also near the Line, where the Weather bears Time with the Seasons in South Lat. as at *Suranam*, which though it is in North Lat. yet are the Seasons there the same as in South Latitudes; but I know not such another Instance any where. And tho' the dry Season is the Time to gather in the Canes, and the wet Season to plant; yet are they not so limited as to make use only of these Seasons for either; but do it chiefly for their best Convenience; for they may plant at any Time of the Year, and that with good Success: especially after a moderate Shower of Rain, which often happens even in the dry Seasons. But I must proceed.

I have said before that Bays have greater Quantities of Rain than Head-Lands.

The Bay of *Campeachy* is a good Instance of this; for the Rains are very great there, especially in the Months of *July* and *August*. On the contrary, the Coast from Cape *Catoch*, to Cape *Condecedo*, which lies more exposed to the Trade, has not near the Rains as the Bay of *Campeachy* hath.

The Bay of *Honduras* also is very wet, and all that bending Coast from Cape *Gratia de Dios*, even to *Carthagena*. But on the Coast of *Caraccos*, and about Cape *La Vela*, where the Breezes are more brisk, the Weather is more moderate. Whereas in those little Bays between, there is still a Difference: For in the Bay of *Mericaya*, which lies a little to the East of Cape *La Vela*, there is much more Rain than at or near the Cape.

The Bay of *Panama* also will furnish us with a Proof of this, by its immoderate Rains; especially the South-side of it, even from the Gulph of St. *Michael*, to Cape St. *Francis*; the Rains there are from *April* till *November*; but in *June, July*, and *August*, they are most violent.

There are many small Bays also West from the Bay of *Panama*, which have their Shares of these wet Seasons, as the Gulph of *Dulce, Caldera* Bay, *Amapalla*, &c. but to the West of that, where the Coast runs more plain and even, there are not such wet Seasons; yet many times very violent Tornadoes.

The *East-Indies* also has many Bays that are subject to very violent Rains, as the Bay of *Tonqueen*, that of *Siam*, the Bottom and the East-side of the Bay of *Bengall*. But on the Coast of *Coromandel*, which is the Westside of that Bay, the Weather is more moderate; that being an even, plain, low Coast. But on the Coast of *Mallabar*, which is on the Westside of that Promontory, the Land is high and mountainous, and there are violent Rains. Indeed the West-sides of any Continents are wetter than the East-sides, the Coast of *Peru* and *Africa* only excepted; in the former of which the Dryness may be occasioned (as is said before) by the Height of the *Andes*. And 'tis probable that the Violence of the Rains near those Mountains falls chiefly on the East-sides of them, and seldom reaches to their Tops: which yet if the Rains do, they may there be broke in pieces, and reach no further. For, among other Observations, I have taken Notice that Mountains are supplied with more Rains than low Lands, I mean the low Land bordering on the Sea. As for Instance, the South-side of *Jamaica* beginning at *Leganea*, and from thence away to the Westward, as far as Black River, including all the plain Land and Savannahs about St. *Jago de la Vega*, *Old Harbour* and *Withywood* Savannahs. This is a plain level Country for many Miles lying near East and West, having the Sea on the South, and bounded with Mountains on the North.

Those Mountains are commonly supplied with Rain before the low Lands. I have known the Rains to have begun there three Weeks before any has fallen in the plain Country, bordering on the

Sea; yet every Day I have observed very black Clouds over the Mountains, and have heard it thunder there. And those very Clouds have seemed by their Motion to draw towards the Sea, but have been check'd in their Course, and have either returned towards the Mountains again, or else have spent themselves before they came from thence, and so have vanished away again to the great Grief of the Planters, whose Plantations and Cattle have suffered for want of a little Moisture. Nay, these Tornadoes have been so nigh, that the Sea Breeze has died away, and we have had the Wind fresh out of the Clouds, yet they have vanished, and yielded no Rain to the low parch'd Lands.

And I think that the want of seasonable Showers is one of the greatest Inconveniences that this part of the Country suffers, for I have known in some very dry Years, that the Grass in the Savannahs has been burned and wither'd for want of Rain, and the Cattle have perished thereby for want of Food. The Plantations also have suffered very much by it; but such dry Seasons have not been known on the North-side of the Island where the Mountains are bordering on the Sea, or at least but a little Distance off it. For there they are supplied with seasonable Showers almost all the Year, and even in the dry time it self near the Full and Change of the Moon. But in the wet Season, the Rains are more violent, which is their Inconvenience.

As for the Valleys in the Country, they are not subject to such Droughts as the plain Land by the Sea, at least I have not observed it my self, nor have I heard it mentioned by others.

The Isle of *Pines* near *Cuba* is so noted a Place for Rain that the *Spaniards* inhabiting near it on *Cuba*, say that it rains more or less every day in the Year, at one Place or another. It is generally spoken also and believ'd by Privateers, for it has been oft visited by them. I have been there my self, but cannot confirm that Report. However, it is well known to be a very wet and rainy Place.

It is but a small Island of about nine or ten Leagues long, and three or four broad; and in the midst is a high peeked Mountain, which is commonly clouded; and the Privateers say that this Hill draws all the Clouds to it; for if there is not another Cloud to be seen any where else, yet this Hill is seldom or never clear.

Gorgonia in the *South-Seas* also has the same Report. It is much smaller than Pines. I have mentioned it in my *Voyage round the World*, Chap. VII. Page 172 [123].

This Isle lies about four Leagues from the Main: but the Isle of *Pines* not above two, and is a great deal bigger than it. The Main against *Gorgonia* is very low Land; but *Cuba* near *Pines* is pretty high, and the Mountain of Pines is much bigger and higher than the Hill of *Gorgonia*, which yet is of a good Height, so that it may be seen sixteen or eighteen Leagues off; and tho' I cannot say that it rains every day there, yet I know that it rains very much and extraordinary hard.

I have been at this Isle three Times; and always found it very rainy, and the Rains very violent. I remember when we touch'd there in our Return from Captain *Sharp*, we boiled a Kettle of Chocolate before we clean'd our Bark; and having every Man his Callabash full, we began to sup it off, standing all the Time in the Rain; but I am confident not a Man among us all did clear his Dish, for it rained so fast and such great Drops into our Callabashes, that after we had sup'd off as much Chocolate and Rain-water together as sufficed us, our Callabashes were still above half full; and I heard some of the Men swear that they could not sup it up so fast as it rained in; at last I grew tir'd with what I had left, and threw it away: and most of the rest did so likewise.

As Clouds do usually hover over Hills and Mountains, so do they also keep near the Land. I have mentioned something of this in my *Voyage round the World*, Chap. X. Page 283 [195,196], where I have said, that in making Land we commonly find it cloudy over the Land, tho' 'tis clear every where beside: And this may still confirm what I have said in the foregoing Discourse, that Hills are commonly clouded; for high Land is the first discerned by us, and that, as I said before, is commonly clouded. But now I shall speak how we find the Clouds, when we are but a little way from Land, either coasting along the Shore, or at an Anchor by it. I hope the Reader will not imag-

ine that I am going to prove that it never rains at Sea, or but very little there; for the contrary is known to every Body, and I have already said in this Discourse of Winds in my first Chapter, That there are very frequent Tornadoes in several Seas especially near the Equator, and more particularly in the *Atlantick Sea*. Other Seas are not so much troubled with them; neither is the *Atlantick* so to the North or South of the Line; especially at any considerable Distance from the Shore, but yet 'tis very probable however, that the Sea has not so great a Portion of Tornadoes as the Land hath. For when we are near the Shore within the Torrid Zone, we often see it rain on the Land, and perceive it to be very cloudy there, when it is fair at Sea, and scarce a Cloud to be seen that way. And tho' we have the Wind from the Shore, and the Clouds seeming to be drawing off, yet they often wheel about again to the Land, as if they were magnetically drawn that way: Sometimes indeed they do come off a little; but then they usually either return again or else insensibly vanish; and that's the Reason that Seamen when they are sailing near the Shore and see a Tornado coming off, they don't much mind it, but cry, *the Land will devour it*: But however, sometimes they fly off to Sea; and 'tis very rare that Tornadoes arise from thence; for they generally rise first over the Land, and that in a very strange manner; for even from a very small Cloud arising over the Top of a Hill, I have often seen it increase to such a Bulk, that I have known it rain for two or three Days successively. This I have observed both in the *East* and *West-Indies*, and in the *South* and *North-Seas*. And 'tis impossible for me to forget how oft I have been disturbed by such small Clouds that appeared in the Night. 'Tis usual with Seamen in those parts to sleep on the Deck, especially for Privateers; among whom I made these Observations. In Privateers, especially when we are at an Anchor, the Deck is spread with Mats to lie on each Night. Every Man has one, some two; and this with a Pillow for the Head and a Rug for a Covering, is all the Bedding that is necessary for Men of that Employ.

I have many times spread my Lodging, when the Evening has promised well, yet have been forced to withdraw before Day; and yet it was not a little Rain that would affright me then; neither at its first coming could I have thought that such a small Cloud could afford so much Rain: And oftentimes both my self and others have been so deceived by the Appearance of so small a Cloud, that thinking the Rain would soon be over, we have lain till we were dropping wet, and then have been forced to move at last. But to proceed.

I have constantly observed, that in the wet Season we had more Rain in the Night than in the Day; for tho' it was fair in the Day, yet we seldom escaped having a Tornado or two in the Night. If we had one in the Day, it rose and came away presently, and it may be we had an Hour's Rain, more or less; but when it came in the Night, though there was little Appearance of Rain; yet we should have it three or four Hours together; but this has commonly been nigh the Shore; and we have seen thick Clouds over the Land, and much Thunder and Lightning, and to our Appearance, there was more Rain there than we had; and probably out farther off at Sea, there might be still less: For it was commonly pretty clear that way.

CHAPTER VIII

OF TIDES AND CURRENTS

The Difference between Tides and Currents. No Place in the Ocean without Tides. Where the Tides are greatest, and where smallest. Of the Tides in the Harbour and Lagunes of Trist*; in the Bay of* Campeachy. *Of those between the Capes of* Virginia. *The Tides in the Gulph of* St. Michael*; and the River if* Guiaquil, *in the* South-Sea. *A mistaken Opinion of a Subterranean Communication between the* North *and* South-Seas, *under the Isthmus if* Darien. *Of the Tides at the* Gallapagos *Islands; at* Guam, *one of the* Ladrones*: About* Panama*; In the Gulph of* Dulce *and* Necoya *River;*

on the Coast of Peru, *in the* West-Indies*; and at* Tonqueen*; where, and at* New Holland, *they are very irregular. A Guess at the Reason of so great an Irregularity. Of the Tides between the* Cape of Good Hope *and the* Red-Sea. *Of Currents. They are influenced by the Trade-Wind. Instances of them at* Berbadoes, *&c. at* Cape La Vela*; and* Gratia de Dios. Cape Roman. *Isle* Trinidado, Surinam; Cape Blanco*; between* Africa *and* Brazil. *Of* Counter-Currents. *Of Currents in the Bay of* Campeachy*; and if* Mexico*; in the Gulph of* Elorida. *Of the* Cacuses. *No strange thing for the Surface of the Water to run counter to its lower Parts. Of the Currents on the Coast of* Angola, *East of the* Cape of Good Hope*: On the Coast of* India, *North of the* Line*: And in the* South-Sea.

HAVING treated of the *Winds* and *Seasons* of the Year in the Torrid Zone, I now come to speak of the *Tides* and *Currents* there.

And by the way *Note*. That,

By *Tides* I mean Flowings and Ebbings of the Sea, on or off from any Coast. Which Property of the Sea seems to be universal; though not regularly alike on all Coasts, neither as to Time nor the Height of the Water.

By *Currents* I mean another Motion of the Sea, which is different from Tides in several Respects; both as to its Duration, and also as to its Course.

Tides may be compared to the Sea and Land-Breezes, in respect to their keeping near the Shore; tho' indeed they alternately flow and ebb twice in 24 Hours. Contrarily the Sea-Breezes blow on the Shore by Day, and the Land-Winds off from it in the Night: yet they keep this Course as duly in a manner as the Tides do. Neither are the Tides nor those Breezes far from the Land.

Currents may be compar'd to the *Coasting Trade-Winds*, as keeping at some farther Distance from the Shore, as the Trade-winds do; and 'tis probable thay are much influenced by them.

'Tis a general Belief, especially among Seamen, That the Tides are governed by the Moon: That their Increase and Decrease, as well as their diurnal Motions, are influenced by that Planet; tho' sometimes accidental Causes in the Winds may hinder the true Regularity thereof.

We are taught, as the first Rudiments of Navigation, to shift our Tides; *i.e.* to know the time of full Sea in any Place; which indeed is very necessary to be known by all *English* Sailors, because the Tides are more regular in our Channel, than in other parts of the World.

But my subject being to speak of the Tides within or near the Tropick, I leave those in places nearer *England*, to be discoursed on by Coasters, who are the only knowing Men in this Mystery: They having by experience gained more Knowledge in it than others; and that is always the best Master.

I have not been on any Coast in the World, but where the Tides have ebb'd and flow'd, either more or less; and this I have commonly observ'd, that the greatest Indraughts of Rivers or Lagunes, have commonly the strongest Tides. Contrarily such Coasts as are least supplied with Rivers or Lakes have the weakest Tides; at least they are not so perceptible. Where there are great Indraughts either of Rivers or Lagunes, and those Rivers or Lagunes are wide, though the Tide runs very strong into the Mouths of such Rivers or Lagunes, yet it does not flow so high, as in such Places where the Rivers or Lakes are bounded in a narrow Room, though the Tides do run of an equal strength at the Mouths or Entrances of either. Neither do the Tides flow so much on or about Islands remote from the Main Land, as they do on the Coasts of it.

I shall first give some Instances of these general Observations, and then proceed to Particulars.

The Places that I shall mention shall be such as I have been in my self, and where I have made the Observations before mentioned; I shall begin with the Lagune of *Trist*, in the Bay of *Campeachy*.

This Place is very remarkable, in that it has two Mouths of a considerable bigness; the one is

about a Mile and half wide, and about two Mile through, before you come to a Lagune, which is seven or eight Leagues long, and three wide. The other Mouth is 7 Leagues from it, and is about 2 Miles and half, or 3 Miles wide, and about 2 Miles long, before it opens into the Lagune: Besides, farther within Land there are 3 or 4 more Lagunes less than the former.

The Tides that flow or ebb in all the Lagunes pass in or out at the two Mouths before-mentioned, which makes them run very swift, insomuch that the *Spaniards* have named that great Lagune, *Laguna Termina*, or the Lake of Tides; because the Tides are so very strong in those two Mouths. Yet, though the Tides do run so swift at the Mouth of the Lagune, they do not rise in height proportionable to that swiftness; for the greatest Tides here do not rise or fall above 6 or 7 Foot, except forced by extraordinary Causes, as Storms, or the like: Of which I have spoken before.

I could also instance in the Channel, between the 2 Capes of Virginia, where the Tides do run very swift; yet the Floods and Ebbs are not proportionable to the swiftness of the Tides between the Capes. There are not indeed such Lagunes, as at *Trist* in the Bay of *Campeachy*; but there are many wide Rivers, and abundance of smaller Creeks. Besides, in some places there is low Land, which is over-flown by the Tides; so that all the Water that runs in with such swiftness within the Capes is insensibly swallowed up there.

These are instances of strong Tides, occasioned by great Indraughts; yet where there is but little rising and falling of the Water in comparison with the strength of the Tides at the Mouths of those Indraughts. I shall next give some Instances of the great Indraughts, where the Tides flow and ebb much more than in the former Places; though the Tide at the Mouths of those Indraughts does not run swifter than in those Places before mentioned.

I shall only mention two Rivers in the *South-Sea*, that I have taken notice orin my *Voyage round the World* (*viz.*) the Gulph of St. *Michael*; and the River of *Guiaquil*.

In the Gulph of St. *Michael* there are many large Rivers, which all disembogue into a Lagune of 2 or 3 Leagues wide. This Lagune is barricadoed from the Sea with some small low Mangrovy Islands, and between them are Creeks and Channels, through which the Tides make their daily passes into the Lagune; and from thence into the Rivers, and so back again; many times over-flowing the said Islands, and leaving the tops of the lower Trees above Water.

The Rivers that run into this Lagune are pretty narrow, and bounded on each side with steep Banks, as high as the Floods use to rise, and but very little higher. For at High-water, and on a Spring-tide, the Water is almost, or altogether even with the Land.

The Lagune at the Mouth of the Rivers is but small, neither is there any other way for the Water to force it self into, beside the Lagune and Rivers; and therefore the Tides do rise and fall here 18 or 20 Foot.

The River of *Guiaquil*, in this respect, is much the same with the Gulph of St. *Michael*; but the Lagunes near it are larger. Here the Tide rises and falls 16 Foot perpendicular.

I don't know of any other such Places in all the *South-Seas*; yet there are other large Rivers on the Coast, between these Places; but none so remarkable for high Tides. The great Tides in the Gulph of St. *Michael* have doubtless been the occasion of that Opinion, which some hold, that there's a subterranean Communication between the N. and the *South-Seas*; and that the Isthmus of *Darien* is like an Arched Bridge, under which the Tides make their constant Courses, as duly as they do under *London-Bridge*. And more to confirm this Opinion some have said, that there are continual and strange Noises made by those Subterranean Fluxes and Refluxes; and that they are heard by the Inhabitants of the Isthmus; and also that Ships sailing in the Bay of *Panama* are toss'd to and fro at a prodigious rate: Sometimes (say they) they are by the boiling of the Water, dash'd against Islands; and in a moment left dry there, or staved in pieces; at other times they are drawn or suck'd up, as 'twere, in a Whirl-Pool and ready to be carried under Ground into the North-Seas,

with all Sails standing. They have said also, that when the Tide flows, especially on a Spring, the Islands in the Bay are all overflown; nay, and even the Country for a great way together: and then nothing is to be seen, but the tops of Trees. But if this were so, 'tis much that I and those that I was with, should not have heard or seen something of it: For I pass'd the Isthmus twice, and was 23 Days in the last Trip that I made over it; but yet did I never hear of any Noises under Ground there. I sailed also in the *South-Seas* (taking in both times that I was there) near 3 Years: and several Months of it I was in the Bay of *Panama*. And after I went away those of our Crew that remained there, spent a great deal more time in that Bay. Yet did they never meet with such strange Whirl-Pools, but found as pleasant sailing there, as any where in the World. Neither did I ever hear any of the *Spaniards* or *Indians* make mention of any such thing in all my Converse with them; which certainly they would have done, if they had ever experienced it, had it been only to terrifie us, and scare us away from their Coasts.

I remember indeed our Country-man, Mr. *Gage*, gives some hints of these strange Currents in this Bay, in his Book, called, *A New Survey of the West-Indies*, from P. 538 to 440, but I am afraid he took most of it upon trust from others; or else he was Sea-sick all that little Voyage: for he gives a very imperfect and lame Account of that Business, as if he understood not what he wrote. I should dislike his whole Book for that one Story's sake, if I did not know that he has written candidly upon other Matters; but I think I have said enough of this: To Proceed then.

As to the great Tides, which are reported to be in these Seas, I have given instances of them, but they are not so great as is reported; neither do they ebb and flow so much any where as in the Gulph of St. *Michael* only: where indeed they flow over those small low Mangrove Islands, at the Mouth of the Lagune, and leave only the tops of the low Trees above Water; for those Islands are very low, neither do they afford any high Trees. But however, the Islands at the Mouth of the Gulph, before you come to these low ones, are near over-flown; yet are they very small and low, in comparison with other Islands in the Bay of *Panama*. And indeed should the Islands in that Bay be over-flown, the City of *Panama* would soon be many Yards under Water. But so far is this from being true, that the *Pearl Islands* which are very flat and low, are yet never overflown. For there the Tide riseth and falls not above 10 or 11 Foot on a Spring, at the Southermost end of them, which is almost opposite to the Gulph of St. *Michael*, and not above 12 or 14 Leagues distant from it. And yet there it flows more than it does at or near *Panama*, or any other Place in the Bay (except just at the Mouths of Rivers) by 2 or 3 Foot. Therefore all that report is wholly groundless.

But to go on.

I have also observed, that Islands lying afar off at Sea, have seldom such high Tides as those that are near the Main, or as any Places on the Main it self; as for example, at the *Gallapagos Islands*, which lie about 100 Leagues from the Main; the Tides don't rise and fall above a Foot and half, or two Foot, which is less than they do on the Coast of the Main. For on most Places of the Main it rises and falls 2 or 3 Foot, more or less according as the Coast is more or less exposed to Indraughts or Rivers.[10]

Guam, one of the *Ladrone* Islands, is also another instance of this. There the Tide riseth not above 2 or 3 Foot at most. In the Bay of *Panama* the Tides do keep a more constant and regular Course than on other Places on the Coasts of *Peru* and *Mexico*; it was for that reason I called them Currents in some Places (mentioned in my *Voyage round the World*, as particularly near *Guatuloa*, on the *Mexican Continent*, in Chap. IX. Page 238 [166]), but it was truly a Tide (which there I called a Current) and it sets to the Eastward as the Ebb doth to the West. The Tides there do rise and fall about 5 Foot, as they do on most part of that Coast.

[10] See page 599

At *Ria Leja* they rise and fall about eight or nine Foot.

At *Amapala* they also rise and fall about 8 or 9 Foot, and the Flood there runs to the East, and the Ebb to the West.

In the Gulph of *Dulce* and *Neicoya* River, they rise to 10 or 11 Foot; but on the Coast of Peru they don't rise so high, especially on all the Coast between Cape St. *Francis* and the River *Guiaquil*; there the Flood runs to the South, and the Ebb to the North.

At the Island *Plata* the Tide rises and falls 3 or 4 Foot; but from Cape *Blanco*, in about 3 d. South, to 30 d. South, the Tides are smaller; there they rise and fall not above a Foot and a half, or 2 Foot. The Flood on this Coast sets to the South, and the Ebb to the North.

In all my Cruisings among the Privateers, I took notice of the Risings of the Tides; because by knowing it, I always knew where we might best haul ashore and clean our Ships: which is also greatly observed by all Privateers.[11]

In most Places of the *West-Indies*, the Tide flows but little over what it does in our Channel.

In the *East-Indies* also the Tides are but small on most Coasts, neither are they so regular as with us.

The most irregular Tides that I did ever meet with, are at *Tonqueen* in about 20 d. North Latitude, and on the Coast of *New-Holland*, in about 17 d. South. In both these Places, the neap Tides are scarce discernable.[12] Those of *Tonqueen* are described at large by Mr. *Davenport*, who was imployed by Mr. *James* when he was Chief of the *English* Factors there, to observe them: And the whole Discourse is published in *The Philosophical Transactions of the Royal Society*: whither I refer you.

At *New-Holland* I had two Months time to observe the Tides. There the Flood runs E. by N. and the Ebb W. by S. And they rise and fall about five Fathom.[13]

In the Springs that we lay here, the highest were three Days after the Full or Change, and that without any perceptible Cause in the Winds or Weather. I must confess we were startled at it; and though some of us had observed it in the Springs, that happened while we lay on the Sand to clean our Ship,[14] (as I have mentioned in my former Volume, Entitled, *A new Voyage round the World*, Ch. XVI. Page 469 [316]), yet in that Spring that we designed to haul off, in order to be gone from thence, we did all take more particular Notice of it than in the preceding Springs; for many had not taken notice of it before: And therefore the Major-part of the Company, supposing that it was a Mistake in us who made those former Observations, expected to haul off the' Ship the third Tide after the Change; but our Ship did not float then, nor the next Tide neither, which put them all into an Amazement, and a great Consternation too: For many thought we should never have got her off at all, but by digging away the Sand; and so clearing a Passage for her into the Sea. But the sixth Tide cleared all those Doubts; for the Tide then rose so high, as to float her quite up; when being all of us ready to work, we haul'd her off; and yet the next Tide was higher than that, by which we were now all throughly satisfied, that the Tides here do not keep the same time as they do in *England*.

This I must also observe, That here was no River, nor Lagune, nor any other Indraught on the Land near us, that might occasion these great Tides; tho' 'tis very probable that the great Bending between *New-Holland* and *New-Guinea*, may have both Rivers and Lagunes, which may cause

[11] See page 599

[12–14] See page 600

these great Tides; or else there may be a Passage of -the Sea between both Places; as it is laid down in some Draughts: Or if neither of these, there may be at least a large and deep Sound.

This is the more probable, because of the extraordinary Flood that sets to the East-ward in all that Sea, between *New-Holland*, and the Islands lying North of it, which we most sensibly perceived, when we were near *New-Holland*: And such a Tide as this must of Necessity have a greater Indraught than barely a River or Lagune; and 'tis the more likely still, that this Tide should have a Passage through between *New-Holland* and *New-Guinea*, or at least a deep Sound there; because it keeps along by the Main, and doth not run in among the Islands to the North of it. And besides, the Northermost Promontory of *New-Holland* shoots down almost to the Line, which seems to be a Barrier to it on that side; therefore it may in Reason be supposed to have its Passage some other way; but of this guess, I have said enough.[15]

In the Streights of *Malacca* the Flood sets to the East, and the Ebb to the West.

I have found the Tides at *Malacca* Town, to rise and fall about six Foot on a Spring. I had the Experience of two Spring-Tides, when I was Captain Minchin's Mate, as is before-mentioned in my Voyage from *Achin* to *Malacca*.

On the East-side of the *African* Coast, between the *Cape of Good Hope* and the *Red Sea*, the Tide keeps its constant Course. The Flood runs to the Southward; the Ebb to the Northward. And at a Spring-tide in the Rivers on that Coast, the tide rises and falls six Foot, especially in the River of *Natal*, in Lat. 30 d. South.

I have this Relation from Capt. *Rogers*, who is a very ingenious Person, and well experienced on that Coast; and is now gone Commander of a small Vessel thither to trade.

Having already largely treated of Tides, I come now to speak somewhat of Currents.

CURRENTS and Tides differ many ways; for Tides run forward, and back again, twice every twenty-four Hours: on the contrary Currents run a Day, a Week, nay, sometimes more, one way: and then, it may be, run another way.

In some particular Places they run six Months one way, and six Months another.

In other Places they constantly run one way only a day or two, about full Moon, and then they run strong against the former Course; and after that, return the same way again.

In some Places they run constantly one way, and never shift at all.

The Force of Tides is generally felt near the Shore; whereas Currents are at a remote Distance; neither are the Effects of them sensibly discerned by the rising or falling away of the Water as those of the Tides are; for these commonly set along Shore.

'Tis generally observed by Seamen, that in all Places where Tradewinds blow, the Current is influenced by them, and moves the same way with the Winds; but 'tis not with a like Swiftness in all Places; neither is it always so discernable by us in the wide Ocean, as it is near to some Coast; and yet it is not so discernable neither, very near any Coast, except at Capes and Promontories, that shoot far forth out into the Sea; and about Islands also the Effects of them are felt more or less, as they lye in the way of the Trade-Winds.[16]

I shall Instance *Barbadoes* for one, and all the Caribbees may as well be included.

[15] See page 600

[16] See page 601

The greater Islands, as *Hispaniola*, *Jamaica* and *Cuba* have only some particular Capes or Head-Lands, exposed to Currents, as Cape *Tiberoon* on *Hispaniola*, *Point Pedro*, and the N.E. Point of *Jamaica, Cape de Cruz, Cape Corientes*, and *Cape Antonios* on *Cuba*: But of all the Islands in the *West-Indies* there are none more sensible of Currents than *Corrisao* and *Aruba*, nor any Capes on the Continent so remarkable or Currents as *Cape Roman*, which shoots out against the Sea, between those two Places, as also *Cape Coquibaco* and *Cape La Vela* to Leeward, all three on the same Head-Land, which shoots forth far, without any other Land on the Coast.

There is no such Head-Land till you come to *Cape Gratia de Dios*, which is about 260 Leagues to Leeward: Indeed to the Eastward there is Land that trends out almost so far, within 150 Leagues of it: (*viz.*) The Island *Trinidado* and the Land against it; and there also are great Currents. But I shall first speak of the Currents between *Cape La Vela* and *Cape Gratia de Dios*.

The Currents at *Cape La Vela* do seldom shift, therefore Ships that ply to Windward to get about it, do not ply near the Shore, but stand off to Sea, till they come in Sight of *Hispaniola*; and then back again, till within about six or eight Leagues of the Cape, but not nearer. But in the Westerly Wind-Season, which is from *October* till *March*, Ships often meet Westerly Winds that last two or three Days with which they may run to the Eastward, without any Trouble.

Between *Cape La Vela* and *Cape Gratia de Dios*, the Currents are much different from what they are against the Cape: and this seems to proceed from the Make of the Land; for the Shore between the two Capes, runs into the Southward, making the great Bay: And this Bay affords more Varieties of Winds and Currents, than anyone part of the *West-Indies* besides.

Here, in the Westerly Wind-Season, the Current sets to the Westward constantly; but sometimes stronger than at other times. At about four Leagues off Shore, you find it, and so it continues till you are 20———25, ———— or 30 Leagues off. Beyond that you meet with an Easterly Wind; and if there is any Current it runs also to the Westward: therefore Ships that are bound to the Westward, must run off to Sea thirty or forty Leagues to get a Wind, or else if they have but a little way to go, they must ply close under the Shore, that so they may anchor when they please: Otherwise they will be carried away to the Eastward, fourteen or sixteen Leagues in a Night's time; and that too, though they have a faint Easterly Wind, as frequently they meet with, though 'tis the Westerly Wind-Season.

To the East of *Cape Roman*; as high as the Island *Trinidado*, you meet only a soaking faint Current, setting to the Westward, except only near such places as shoot out farthest into the Sea, as about the *Testegos*, which are small Islands lying to Wind-ward 'of the Island *Margarita*. Between those Islands and the Main, you meet with a pretty strong Current: therefore it is hard getting to the Eastward there; but on all the Coast, between *Cape Roman* and the Head-Land, shooting out towards the *Testegos*, you may ply up with the Land and Sea-Breezes.

From thence, till you come as high as the East-end of *Trinidado Isle*, you meet with an extraordinary strong Current.

From the East-end of *Trinidado*, till you come to Surinam, though you meet an Easterly Current, yet 'tis possible to beat it up with the Land and Sea-Breezes.

From Surinam also to *Cape Blanco*, you may turn it up, though to be sure you'll meet with Currents setting to the West; except near the Full of the Moon; and then on all the Coasts before mentioned, we commonly meet with Currents, setting to the Eastward; at least then it slackens and stands still, if it doth not run to the Eastward. But when you are come as far to the East as *Cape Blanco*, on the North of *Brazil*, you meet with a Current always against you; and so from thence Southerly, as far as Cape St. *Augustine*.

There is no dealing with this Promontory; for it shoots out so far into the Sea, and thereby lies so exposed to the Sea-Breezes and the Currents, that soak down between *Africa* and *Brazil*, that it is quite contrary to Reason to think there should not always be a strong Current setting to the N.W.

I have before hinted, That in all Places where the Trade blows, we find a Current setting with the Wind, which is not so perceptible in the wide Sea as nearer the Shores; yet even there the Force of the Winds constantly blowing one way, may, and probably does, move the Surface of the Water along with it.[17]

From hence it may be inferred, that the Southerly Winds on the Coast of *Africa*, and the true Trade between it and *Brazil*, gently move the surface of the Sea with it, and the Trade being mostly at S.E. drives the Sea to the Northward, slanting in on the Coast of *Brazil*; which being there stopp'd by the Land, bends its Course Northerly towards *Cape* St. *Augustine*: And after it has doubled that great Promontory, it falls away more gently towards the Coast of *Surinam*; and from thence towards the *West-Indies*. For after it has doubled that Promontory, it has more room to spread itself, and thereby becomes weaker in Motion, being agitated by the Trade-winds, which to the North of the Line, we find commonly blowing at E.N.E. and this still bears the Sea slanting down along the Coast to the Westward. And probably 'tis for this Reason, that we find the Current setting strongest near those Head-Lands before-mentioned. Whereas at *Barbadoes*, and other of the Caribbee-Islands, we find only a soaking Current, such as seems to arise only from the Constancy of the Trade-winds blowing there, and not from an Original Current, from the South-part of the *Atlantick*: which, as I said before, doubles about *Cape* St. *Augustine*, and so coasts along pretty nigh the Shore.

The Currents about the Island *Trinidado*, and at *Currisao* and *Aruba*, as also between them and Cape Roman seem to indicate as much. The Currents also between *Cape Roman*, and *Cape La Vela* indicate the same.

From *Cape La Vela* the Currents set still to the Westward, towards *Cape Gratia de Dios*; but in a direct Line, and not borrowing or slanting in towards the Shore. For, as I said before, it is a large Bay, and Currents commonly set from one Head-Land to another; so that Bays have seldom any; or if they have, they are only Counter-Currents. And these Counter-Currents too do set from one Point to another, without interfering with the little Bays between. And 'tis also very probable that these Counter-Currents, such as 'we meet with in this Bay, in their Seasons, after they have surrounded the Bay, and are got as far to the East as *Cape La Vela*, wheel off there, and turn about again with the Stream to the Westward like an Eddy in a River.

From *Cape Gratia de Dios* the Current sets away N.W. towards *Cape Catoch*, and so passes away to the Northward, between Cape *Catoch* on *Jucatan*, and Cape *Antonio* on *Cuba*.

In the Channel between those two Capes, we commonly find a strong Current setting to the Northward: And here I have found them extraordinary strong.

On the North-side of *Jucatan*, as you pass into' the Bay of *Campeachy*, you meet with a small soaking Current to the Westward, even down to the bottom of the Bay of Mexico; but on the North-side of the Bay of *Mexico* the Current sets to the Eastward: And 'tis probable that is the reason, that the *Spaniards*, coming from *La Vera Cruz*, keep that shore aboard. And 'tis as probable that the Current, which sets to Leeward on all the Coast from Cape St. *Augustine* to Cape *Catoch*, never enters the Bay of *Mexico*; but bends still to the Northward, till 'tis check'd by the *Florida* shore; and then wheels about to the East, till it comes nearer the Gulph's Mouth, and there joyning with

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the soaking Current that draws down on the North-sides of *Hispaniola* and *Cuba*, passes altogether with great strength through the Gulph of *Florida*, which is the most remarkable Gulph in the World for its Currents; because it always sets very strong to the North. Yet neat the shores on each side this Gulph, there are Tides, especially on the *Florida* shore; and Ships may pass which way they please, if they are acquainted.

It has formerly been accounted very dangerous to meet with a North in this Gulph; and for that Reason our *Jamaica* Ships to avoid them, have rather chosen to go to the Eastward, and pass through the *Cacuses* in the Season that the Norths do blow. The *Cacuses* are Sands that lye off the N.W. end of *Hispaniola*. Those that went from *Port-Royal* in *Jamaica* had good Reason for this; for if a North took them at their going out, it would help them forward in their way, which, should they have been going towards the Gulph, it would obstruct them. Then besides, if a North take a Ship in the Gulph, the Wind blowing against the Current makes an extraordinary Sea, and so thick come the Waves one after another that a Ship can't possibly live in it; yet of late they go through at all times of the Year and if a North takes them in the Gulph, they put away right before the Wind and Sea, with a small Head-Sail; yet the Current is then as strong or stronger then at other times; and forces them back, stern foremost against both Wind and Sea: For tho' the surface of the Sea is raised in Waves' and driven violently with the Winds to the Southward, yet the Current underneath runs still to the Northward; neither is it any strange thing to see two different Currents at one place and time, the superficial Water running one way, and ,that underneath running a quite contrary: For sometimes at an Anchor, I have seen the Cable carryed thus by two different Streams, the under part having been doubled one way, and the upper part the contrary.[18] But 'tis certain, in all other parts of the World, the Current shifts at certain times of the Year; As in the *East-Indies* they run from East to West one part of the Year, and from West to East the other part: Or as in the *West-Indies* and *Guinea*, where they shift only near a Full Moon. This is meant of parts of the Sea near any Coast; yet there are strong Currents in the wide Ocean also, setting contrary to the Rules before going: I mean against the Trade; but 'tis not common.

On the Coast of Guinea the Current sets East, except at or near a full Moon; but to the South of the Line from *Loango*, to 25 or 30 d. the Current sets with the Wind from S. to N. except near the Full.

To the Eastward of the *Cape of good Hope*, from 30 d. South, to 24 d. South, the Currents from *May* till *Oct.* set E.N.E. and the Winds then are at W.S.W or S.W, but from *Oct.* till *May* when the Winds are between the E.N.E. and E.S.E. the Currents run to the West. These Currents are thus found from 5 or 6 Leagues off the shore to about 50. Within 5 Leagues off the Shore you have the Tide, and not a Current; and being past 50 Leagues off Shore, the Current either ceaseth quite, or is imperceptible.[19]

On the Coast of *India*, North of the Line, the Current sets with the Monsoon, but does not shift altogether so soon, sometimes not by 3 Weeks or more and then never shifts again till after the Monsoon is settled in the contrary way. As for Example, the West Monsoon sets in the middle of *April*, but the Current does not shift till the beginning of May: So when the East *Monsoon* sets in about the middle of *September*, the Current does not shift till *October*.[20]

In the *South-Seas* on the Coast of *Peru*, the Current sets from South to North, even from 30 d. to the Line, and to 3 or 4 d. North of it.

At the *Gallapagos Islands* we found a soaking Current, not very strong, but so strong that a ship could get very little by turning; and 'tis probable that nearer the Main, they are stronger because of the constant Southerly Winds.

[18–19] See page 601

[20] See page 602

At the *Gallapagos Islands* we found a soaking Current, not very strong, but so strong that a ship could get very little by turning; and 'tis probable that nearer the Main, they are stronger because of the constant Southerly Winds.

The most remarkable Places for Currents in the *South-Seas*, are Cape St. *Francis*, Cape *Passao*, Cape St. *Laurence* and Cape *Blanco*. This last has commonly very strong Currents setting to the N.W. which hinders Ships mightily; and the more because it is a very windy place; so that many times Ships are not able to carry their Top-sails; and then it is but bad plying to Windward against a Current. I had not so much Experience of the *Mexican* Coast, because we. commonly kept within the Verge of the Tides. But on the Coast of *Guatamala*, in the Lat. of 12 d. 50 m. ahd 13 d. we had a Current setting S.W. and it is probable that there also the Current sets with the Winds. For, as it is before noted, the Currents on all Coasts sets as the coasting Trade does.

And thus have I finished what my own Experience, or Relations, from my Friends, have furnished me with on this useful Subject of *Winds, Tides, Currents, &c.* which I humbly offer, not as a compleat and perfect Account, but as a rude and imperfect Beginning or Specimen of what may better be done by abler Hands hereafter. And I hope this may be useful so far as to give a few Hints to direct the more accurate Observation of others.[21]

[21] See page 602

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Review of the Toadfish Genera (Teleostei: Batrachoididae)

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The family Batrachoididae is represented by 25 genera and 78 species occurring worldwide between about 51°N and 45°S along continents in marine and brackish waters, occasionally entering rivers, with several freshwater species in South America. They have limited dispersal ability because they have demersal eggs and lack pelagic larvae. A phylogenetic analysis using Paup with 50 informative characters and *Draconetta*, *Ogilbia*, *Raniceps*, and *Synchiropus* as outgroups, resulted in the recognition of two major clades, New World and Old World. The subfamilies Porichthyinae and Thalassophryninae are retained; however the subfamily Batrachoidinae is restricted to the New World and a new subfamily, Halophryninae, is recognized for the Old World genera. *Triathalassothia*, which occurs in southeastern South America, is regarded as *incertae sedis* being either basal to the New World or Old World clade. There is close correspondence between various recognized clades and their geographic locations. *Batrichthys felinus* Smith is removed to *Chatrabus*.

The family Batrachoididae is the only family in the order Batrachoidiformes (Haplodoci). These small to medium-sized fishes (to 57 cm) are easily recognized by their characteristic shape, with a large, broad, flattened head, often with barbels and/or fleshy flaps around their large mouths, and a tapering body. The eyes are on top of the head and directed upwards. Moderately strong teeth are present in the jaws and on the roof of the mouth. Spines are present on the opercle and often the subopercle. There are two separate dorsal fins, the first with two or three spines, and the second long with up to 40 soft rays. The anal fin is somewhat shorter than the second dorsal with up to 39 rays. The pectoral fins are large and broad based and the pelvic fins are jugular in position with one spine and three soft rays. Glandular tissue may be present in the opercular region and pectoral-fin axil or between the pectoral-fin rays. The skin may be scaly or naked. The lateralis system is very well developed, with either single or multiple lateral lines, each pore usually surrounded by two tentacles. Gill openings are usually, but not always, small and restricted to the sides of the body. The number of vertebrae ranges from 25 to 47. The swimbladder is well developed, and used for sound production in many species. Species of *Porichthys* have photophores along their sides and ventral surface. Species in the subfamily Thalassophryninae have hollow, venomous spines in their first dorsal fin and opercles. *Bifax lacinia* has a flap with an eye spot at the end of the maxilla on each side of the mouth. Toadfishes usually are rather drab colored, often brownish with darker saddles, bars, or spots; however, some species in the Atlantic genus *Sanopus* are bright-

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ly colored as is *Bifax lacinia* from the Gulf of Oman. Maximum size of species ranges from 56 mm to at least 570 mm standard length.

The toadfishes, called frogfishes in Australia, are found worldwide between about 51°N and 45° S along continents in marine and brackish waters, occasionally entering rivers, with several freshwater species in South America. They are found from the shoreline down to a depth of at least 366 m, often burying in the sand or under rocks or coral heads where they function as ambush predators feeding on crabs, shrimps, mollusks, sea urchins, and fishes. Although usually benthic, species of *Porichthys* feed in the water column at night.

The only known toadfish fossil is *Halobatrachus didactylus* from the Miocene Messinian deposits of the Oran region of Algeria (Carnevale 2004).

History of The Classification of the Batrachoididae

Higher Classification.— When Linnaeus described the first toadfish in 1758, he placed it in the Thoracici. In 1801 Bloch and Schneider placed the toadfishes in the Jugularies. Cope (1871) erected the suborder Haplodoci for the toadfishes based on its simple post-temporal (not bifurcate). The history of proposed relationships of the toadfishes is long and varied, starting with Starks (1905) who associated them with the gobiesociforms. Ogilby (1908:44) stated that they were "related on the one hand to the Blenniidae and on the other to the Congrogadidae." Regan (1912) was the first to link the batrachoidiforms with the lophiiforms, placing the toadfishes in the suborder Batrachoidea of the order Pediculati which contained the toadfishes and the Lophioidea with the Lophiiformes, the Antennariiformes, and the Ceratiiformes. Starks (1923:266) later stated that "The Batrachoid fishes doubtless are allied to the Uranoscopoids...." Briggs (1955) believed that the gobiesociforms were most closely allied to the toadfishes, but also showed some resemblance to the Callionymoidea. McAllister (1968) also suggested a relationship between clingfishes and toadfishes. Greenwood et al. (1966) later united the Batrachoidiformes with the Percopsiformes, Gobiesociformes, Lophiiformes, and Gadiformes under their new superorder Paracanthopterygii. Later, Rosen and Patterson (1969) referred to the batrachoidiform lineage, which included the Batrachoidiformes, Lophiiformes, and Gobiesociformes. Lauder and Liem (1983) followed Rosen and Patterson (1969) in placing the batrachoidiforms as the sister group of the lophiiforms and both the sister group of the gobiesociforms. Gosline (1970) questioned the inclusion of the gobiesociforms in the Paracanthopterygii, suggesting they were related to the callionymoids. Later, Patterson and Rosen (1989) agreed with Gosline as did Winterbottom (1993), and Johnson and Patterson (1993) as summarized by Johnson (1993).

Wiley et al. (2000) reported that a batrachoidiform was grouped with an ophidiiform when using molecular techniques. Earlier, Rosen and Patterson (1989, fig. 5), had shown that the ophidioids and batrachoidids shared a unique caudal-fin structure. Miya et al. (2005), using mitochondrial DNA, found the toadfishes to be the sister of a mastacembelid. Smith and Wheeler (2006), using molecular techniques in investigating venom evolution, presented a cladogram that showed toadfishes to be the sister group of the dragonets.

Genera and species.— The first toadfish to be described was *Cottus grunniens* by Linnaeus in 1758, a species from the East Indies now known as *Allenbatrachus grunniens*. Next was *Gadus tau* Linnaeus (1766) from the eastern coast of the United States, now in the genus *Opsanus*. Since that time, the number of valid species described has increased steadily to 78 (Fig. 1).

Ogilby (1908) was the first to revise the family Batrachoididae, recognizing ten genera and 35 species. Miranda-Ribeiro (1915) erected the family Thalassophrynidae for *Thalassophryne* and *Thalassothia* and the family Porichthyidae for *Porichthys*, but subsequent workers have recognized

only the family Batrachoididae for the toadfishes. Smith (1952) was next to deal with toadfish genera on a world-wide basis. In a key to the genera, he recognized three subfamilies, Batrachoidinae, Porichthyinae, and Thalassophryninae. He also recognized 20 genera, four new in this paper, and three others he had described earlier. The subfamily Thalassophryninae contains two genera, *Daector* and *Thalassophryne* (Collette, 1966), and the subfamily Porichthyinae contains *Aphos* and *Porichthys* (Walker and Rosenblatt, 1988). The remaining toadfish genera have been placed in the Batrachoidinae (Greenfield 2006). Since Smith's (1952) summary, Roux and Whitley (1972) described the genus *Perulibatrachus*, Greenfield et al. (1994) described *Bifax*, Collette (1995) described *Potamobatrachus*, Greenfield (1997) described *Allenbatrachus*, and Greenfield (2006) described *Vladichthys* and *Colletteichthys*. Twenty-five genera are currently considered to be valid.

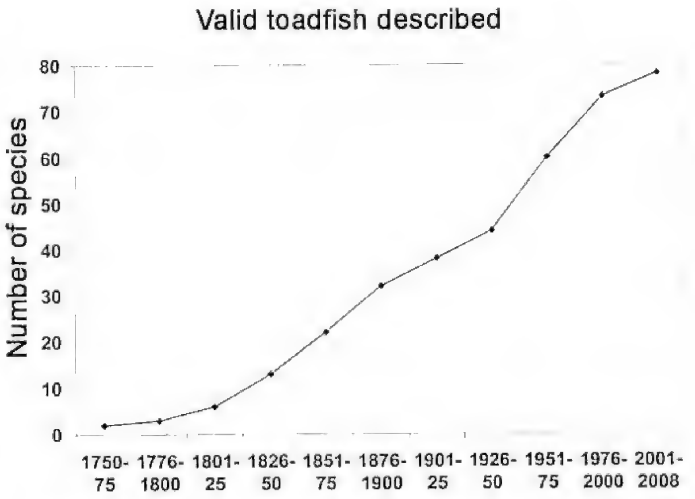

FIGURE 1. Number of valid species described over time.

METHODS

All counts and measurements follow Hubbs and Lagler (1964) except that the last two fin rays are not counted as one unless it is clear that they are joined at the base. Measurements were made to the nearest 0.1 mm using dial calipers. All measurements are expressed as thousandths of standard length (SL). Some counts were made from radiographs. Nomenclatural information is from Eschmeyer (1998 and 2008). Institutional abbreviations are as listed in Leviton et al. (1985). A list of all material examined is given in Appendix 1. At least one species from each genus was cleared and stained. Cleared and stained specimens of *Chatrabus felinus* and *Batrichthys apiatus* were available for comparison, but due to the rarity of *Batrichthys albofasciatus*, only a preserved specimen was available for comparison and various bones were exposed by dissection. Drawings of additional bones of each genus not illustrated here are archived at the California Academy of Sciences.

One of the most difficult aspects of this study was identifying an appropriate outgroup(s) for the Batrachoididae. As discussed above under Higher Classification, proposed relationships have varied greatly. Patterson and Rosen (1989:23–24) reviewed the arguments for the relationship between the lophiiforms and batrachoidiforms, a position that has been accepted by most workers, and provided four putative synapomorphies linking the two taxa. The problem, however, is that the highly derived morphology of the lophiiforms means that most of the bones are so different from the toadfishes that there usually are no shared character states, resulting in little polarization of batrachoid variation. In 1985, Rosen suggested that batrachoids, lophiiforms, gadiforms and bythitoids appeared to form a monophyletic group, based on the shared presence of cartilaginous cores connecting the tips of the exoccipital facets and the prezygapophyses of the first vertebra, rather

than the bone-to-bone of most acanthopterygians. He noted further that this condition differed from that found in ophidioids. Patterson and Rosen (1989:23) suggested that lophiiforms and batrachoidiforms were monophyletic, sharing two apomorphies (elongate proximal radials in the pectoral-fin base and the reduction or loss of the first pharyngobranchial and the suspensory tip of the first epibranchial, and, if present, their lateral displacement away from the second and third pharyngobranchials. They added two further "probable" apomorphies: convergence of the ventral gill arches on a very short copula (basibranchial series), which is unossified or poorly so, and the insertion of the prezygapophyses of the first vertebra into elongate, hollow exoccipital tubes that extend beyond the basioccipital. In addition, they cited (*op. cit.*, fig. 16, legend) another three apparent synapomorphies from Regan (1912: no endo [=meso] pterygoid, post-temporal fused to skull, no pleural ribs) and two from Monod (1960: no intercalary, partially/completely independent ascending process of the premaxillary process). They linked these two taxa (their Pediculati) to the gadiforms, because they share a third pharyngobrancial with three finger-like uncinate processes that articulate with the tips of epibranchials 2–4. They reiterated Rosen's (1985) view that bythitoids (excluding ophidioids) were related to this group; however, Rosen and Patterson (1969:370, legend to Fig. 5), had reported that the ophidioids and batrachoidids shared a unique caudal-fin structure, with the upper hypurals fused with the second ural centrum, the lower hypurals fused with the parhypural, and the uroneurals lost. They cautioned that this was a structural, rather than "phyletic", lineage, and the possible phylogenetic implications were not reflected in their cladogram, nor discussed further in Patterson and Rosen (1989). Markle stated (1989:84) that there "is reason to suggest that they [gadiforms] are more closely related to batrachoidiforms than to any other group (including the Pediculati)" and that "one is justified in considering batrachoidiforms as the appropriate outgroup for gadiform phylogenetic studies since the alternative (lophiiforms) is such a derived group." Markle (1989) placed the Ranicipitidae as basal to other gadiforms. In their monumental work on dorsal gill-arch musculature, Springer and Johnson (2004) pointed out the shared characters between *Raniceps* and *Opsanus*; however, they stated that they did not think this relationship was correct. Although *Raniceps* shares several character states with toadfishes, the bones of the neurocranium, pelvic girdle and caudal-fin structure bear no resemblance to the character states in toadfishes. These characters therefore cannot be polarized when using *Raniceps* as the sole outgroup. Teletchea et al. (2006), however, suggested that *Raniceps* is perhaps part of the Phycinae, and thus not basal among the gadiforms.

Recent molecular phylogenetic studies have also resulted in suggested relationships that provided possibilities for other outgroups for batrachoids, although not without the introduction of considerable differences from each other and from the various morphological hypotheses. For example, Wiley et al. (2000), Miya et al. (2005) and Smith and Wheeler (2006) all report gadiforms as the sister group of zeiforms, and relatively basal in the acanthomorph tree. With somewhat limited taxonomic sampling of the groups of interest here, Wiley et al. (2000) found batrachoids as the sister group to ophidioids, which together form the sister group of pleuronectiforms. Miya et al. (2005) placed the mastacembelids plus *Indostomus* as the sister group of batrachoids, these two being related to an eclectic mix of blennioids, gobiesociforms and various atherinomorphs. The batrachoid lineage is three nodes removed from the ophidioids plus bythitoids (monophyletic), and seven nodes removed from the lophiiformes. Finally, Smith and Wheeler (2006) reported that the draconettids were the sister group of the batrachoids, with callionymids being the next group (i.e. callionymoids are not monophyletic). The sister group to this assemblage was the lophiiform lineage, and the next lineage was comprised of two ophidioid taxa as the sister group of the champsodontids (their exemplar of a bythitoid failed to amplify). Smith (pers. comm., Dec. 2006) also stated "you might want to look at the Callionymioidei for sister-group relationships [to batra-

choids]. I don't know whether Draconettidae + Callionymidae will ever form a clade without the inclusion of the toadfishes." As mentioned earlier, Briggs (1955) also had cited the Callionymoidea along with the toadfishes when discussing the gobiesociforms. We note that toadfishes have one to three long flexible filaments on the subopercle, a character we thought might be unique to toadfishes; however, a single long filament is present in *Synchiropus* and *Draconetta* (Fig. 2). The pectoral fin of toadfishes has elongate pectoral-fin radials with the distal end usually expanded. *Draconetta* also has elongate, expanded radials (Fig. 3). The New World toadfishes have a unique pelvic bone with a foramen in the median process that is also present in *Draconetta* (Fig. 4), but which is absent in callionymids and Old World toadfishes. The neurocranium of toadfishes differs greatly from that found in gadiforms or lophiiforms, but is very similar to those in the Callionymidae (Nakabo 1983, figs. 1–9) (Fig. 5). Toadfishes have either two or three dorsal-fin spines. *Draconetta* also has three spines, whereas all of our other outgroups have more. We also note, however, that callionymids lack the two morphological apomorphies and two putative apomorphies listed by Patterson and Rosen (1989–listed above). They do, however, lack an ossified endopterygoid, pleural ribs and intercalar, the post-temporal is rigidly attached to the skull, and the ascending process of the premaxilla is long and slender.

From the diversity of evidence and conclusions outlined above, we somewhat, but not entirely, arbitrarily chose to use a basal gadiform (*Raniceps*), a bythitoid (*Ogilbia*) and a callionymid (*Synchiropus*) as outgroups for our analysis of the intra-relationships of the batrachoids, based on morphological conclusions. To these we added *Draconetta*, based on the molecular evidence and the number of morphological characters shared with toadfishes.

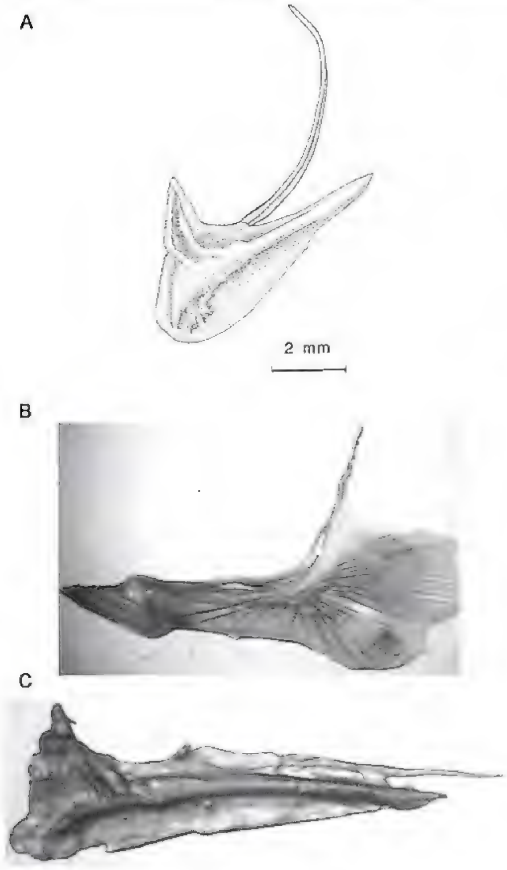

FIGURE 2. Subopercular bones with filaments (left lateral view). A. *Vladichthys gloverensis* FMNH 91036; B. *Synchiropus atrilabiatus*, CAS 168910, 73.0 mm SL; C. *Draconetta oregoni* CAS 168909, 89.4 mm SL.

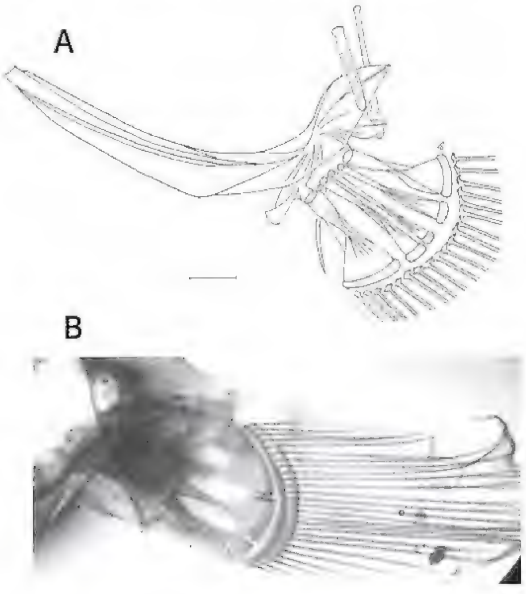

FIGURE 3. Pectoral girdle (left lateral view). A. *Aphos porosus* CAS 65051, scale equal 2 mm; B. *Draconetta oregoni*. CAS 168909, 89.4 mm SL.

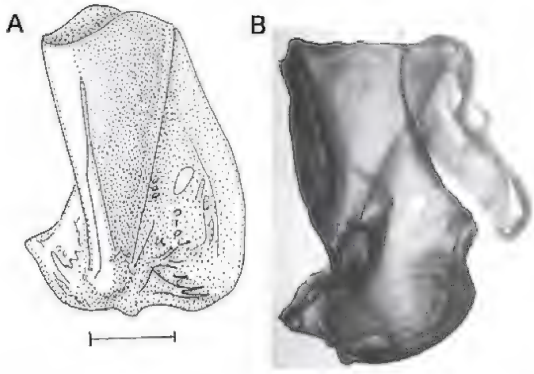

FIGURE 4. Pelvic bones (dorsal view of left pelvic bone). A. *Opsanus tau*, CAS 223821, scale equal 1 mm; B. *Draconetta oregoni*. CAS 168909, 89.4 mm SL.

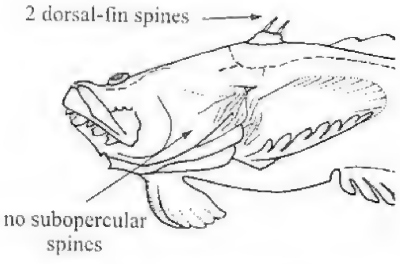

FIGURE 6. Head of *Thalassophryne*. Courtesy of FAO.

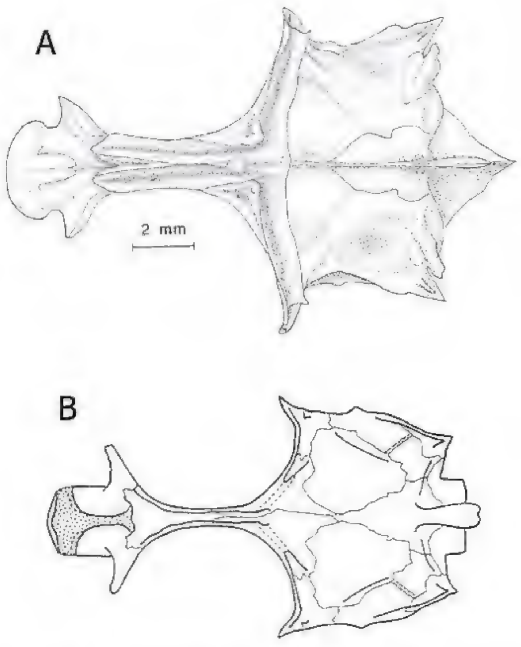

FIGURE 5. Dorsocranium. A. *Chatrabus felinus*, SAIAB 75-25; B. *Paracallionymus costatus* from Nakabo (1983).

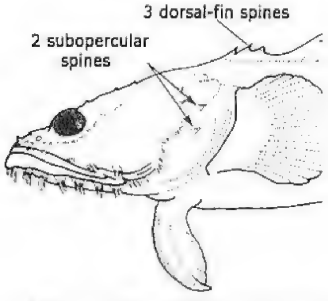

FIGURE 7. Head of *Batrachoides*. Courtesy of FAO.

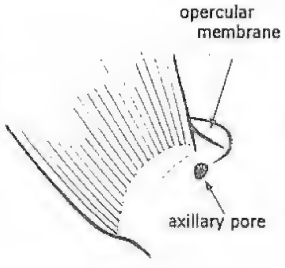

FIGURE 8. Axillary pore. Courtesy of FAO.

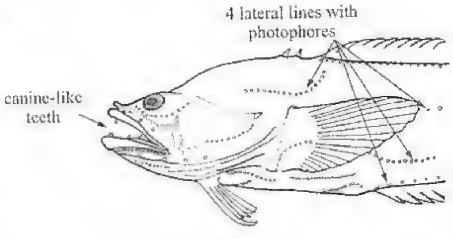

FIGURE 9. *Porichthys*. Courtesy of FAO.

PHYLOGENETIC ANALYTICAL METHODS

Individual data sets, autapomorphies removed, for the ingroup (batrachoids) and each of the outgroups (*Ogilbia*, *Raniceps*, *Synchiropus*, and *Draconetta*) as well as for virtually all combinations of the outgroups (*O* + *R*, O + R + S, R + D, *R* + *S*, R + S + D, and *S* + *D*) were analyzed with Paup 4.0b10 (Swofford, 2000) using PaupUp graphical interface (Calendini and Martin, 2005). All analyses were run with the character states unordered. Heuristic searches with stepwise addition of 10,000 replicates were performed, and strict consensus trees as well as the Consistency Index (CI), Retention Index (RI) and Rescaled Consistency Index (RC) were generated. Bremer support (Decay) indices were obtained by using MacClade ver. 4.0 (Maddison and Maddison, 2000).

Artificial Key to the Genera of Toadfishes (Batrachoididae)

1a. Dorsal-fin spines 2; subopercular spines absent; body naked; no axillary pore behind pectoral fins; canine-like teeth and photophores present or absent (Fig. 6.) 2
1b. Dorsal-fin spines 3; 1 to 3 subopercular spines present; body with or without scales; axillary pore behind pectoral fins present or absent; canine-like teeth and photophores absent (Batrachoidinae and Halophryninae) (Figs. 7 & 8) 5

2a. Dorsal and opercular spines solid with no venom glands under them; several lateral lines present; canine teeth present; pectoral glands present (Porichthyinae) (Figs. 9 & 10) 3
2b. Dorsal and opercular spines hollow with venom glands present under them; lateral line single or absent; canine teeth absent; pectoral glands present or absent (Thalassophryninae) 4

3a. Photophores present; no canines on vomer ..... *Porichthys* (Fig. 21)
3b. Photophores absent; canines on vomer ..... *Aphos* (Fig. 20)

4a. Second dorsal-fin rays 17–21; anal-fin rays 16–20; no discrete glands present on pectoral fin, but glandular tissue scattered on fins (Fig. 11) ..... *Thalassophryne* (Fig. 22)
4b. Second dorsal-fin rays 22–33; anal-fin rays 21–30; 3 to 7 discrete glands located between the bases of the uppermost pectoral rays ..... *Daector* (Fig. 23)

5a. Body completely naked 6
5b. Body with at least some scales (may be embedded and difficult to see) 19

6a. A flap with an eye spot at end of maxilla on each side of mouth ..... *Bifax* (Fig. 35)
6b. Maxillary flaps absent 7

7a. No axillary foramen or pocket 8
7b. Axillary foramen or pocket present (Figure 12) 15

8a. Three subopercular spines ..... *Potamobatrachus* (Fig. 27)
8b. Fewer than three subopercular spines 9

9a. Fewer than 24 dorsal-fin rays; teeth conical or blunt 10
9b. More than 24 dorsal-fin rays (28–29); (teeth short and blunt; a prominent plumose supraorbital tentacle present; venetian blind gland in pectoral-fin axil of adults) (Fig. 13) ..... *Amphichthys* (Fig. 24)

10a. One subopercular spine 11
10b. Two subopercular spines 12

11a. Dorsal-fin rays 20–21; anal-fin rays 15–17; upper lateral-line pores 15–16; lower lateral-line pores 13–19; epaxial trunk musculature not extending forward to cover entire dorsocranium behind orbits (Fig. 14) ..... *Vladichthys* (Fig. 29)
11b. Dorsal-fin rays 14–17; anal-fin rays 11–13; upper lateral-line pores 25–31; lower lateral-line pores 23–31; epaxial trunk musculature extending forward to cover entire dorsocranium behind orbits (Fig. 15) ..... *Triathalassothia* (Fig. 48)

12a. Supraorbital tentacle or tentacles present (Fig. 16); gill openings less or greater than pectoral-fin base 14
12b. No tentacles above eye; gill openings not less than pectoral-fin base 13

13a. Pelvic fins reach vent; head deep, 20% SL or greater; eye equal to or greater than interorbital width ..... *Chatrabus* (in part- *C. felinus*) (Fig. 37)
13b. Pelvic fins not reaching vent; head shallow, depressed, 17 % or less SL; eye less than interor obital width ..... *Batrichthys* (Fig. 34)

14a. Head rounded with lower and upper jaws about equally terminal; eye diameter greater than snout length; interorbital width equal to or less than eye diameter; gill opening clearly above lower margin of pectoral-fin base (Fig. 17) ..... *Halophyrne* (Fig. 45)
14b. Head more pointed and flattened with lower jaw protruding; eye diameter less than snout length; interorbital width greater than eye diameter; gill opening either at or below pectoral-fin base (Fig. 18) ..... *Allenbatrachus* (Fig. 30)

15a. Axillary foramen or pocket at top of pectoral-fin axil; soft dorsal-fin rays 19–24, usually fewer than 24 16
15b. Axillary foramen near center of pectoral-fin axil; soft dorsal-fin rays 23–32, usually 24 or more 18

16a. Supraorbital tentacles present and others on head; anterior nasal tentacle not elongate 17
16b. Supraorbital tentacles absent and few on head; anterior nasal tentacle long ..... *Austrobatrachus* (Fig. 31)

17a. Opening at top of pectoral-fin axil a distinct round hole, not funnel shaped and lacking glandular tissue on ventral margin; lower gill opening at lower pectoral-fin base; subopercle with one strong spine ..... *Batrachomoeus* (Fig. 33)
17b. Opening at top of pectoral-fin axil a funnel-shaped pit with glandular tissue inside and extending from ventral margin onto axil; lower gill opening well below lower pectoral-fin base; subopercle with two spines, upper one large and lower one smaller .... *Colletteichthys* (Fig. 43)

18a. Soft dorsal-fin rays 23–27; anal-fin rays 19–23; discrete glands present on interior surface of pectoral fin between bases of upper fin rays ..... *Opsanus* (Fig. 26)
18b. Soft dorsal-fin rays 29–32; anal-fin rays 24–26; no discrete glands present on interior surface of pectoral fin between bases of upper fin rays ..... *Sanopus* (Fig. 28)

19a. No small, round, foramen in pectoral-fin axil, but a funnel-shaped pocket might be present 20
19b. Small, round foramen present on upper part of pectoral axil beneath upper edge of opercular membrane; (fewer than 24 dorsal-fin rays; no tentacle above eye) .. *Halobatrachus* (Fig. 44)

20a. A more or less funnel-shaped pocket (deep or shallow) present on upper part of pectoral-fin axil 21
20b. Pectoral axil without a pocket 22

21a. No obvious tentacles above eye ..... *Perulibatrachus* (Fig. 46)
21b. One or more prominent tentacles above eye 23

22a. Anal-fin rays 18 or fewer, nasal barbels present (Fig. 19 a.) .... *Chatrabus* (in part) (Fig. 36)
22b. Anal-fin rays 19–27, nostrils tubular, no nasal barbels (Fig. 19 b.) .. *Batrachoides* (Fig. 25)

23a. Scales on body extending forward to first dorsal-fin base; anal-fin rays 13–14; pectoral fin spotted; anterior nostril with a single pointed tentacle ..... *Barchatus* (Fig. 32)
23b. Scales on body restricted to posterior half; anal-fin rays 15–17; pectoral fin without spots; anterior nostril with a large tuft of tentacles ..... *Riekertia* (Fig. 47)

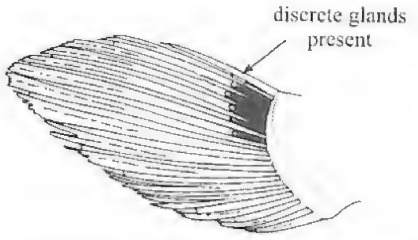

FIGURE 10. Pectoral-fin glands – distinct. Courtesy of FAO.

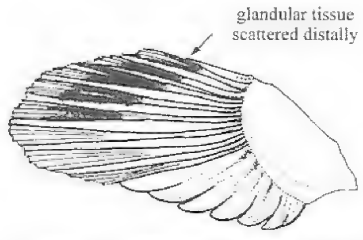

FIGURE 11. Pectoral-fin glands – scattered. Courtesy of FAO.

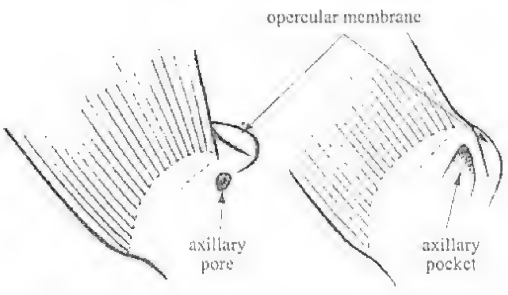

FIGURE 12. Axillary pore and pocket. Courtesy of FAO.

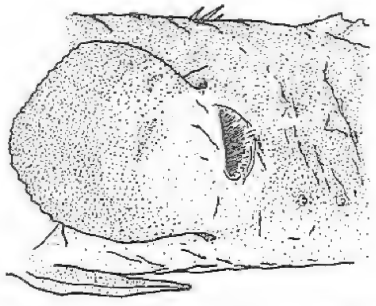

FIGURE 13. Venetian blind gland in pectoral-fin axil of *Amphichthys* (from Breder 1925).

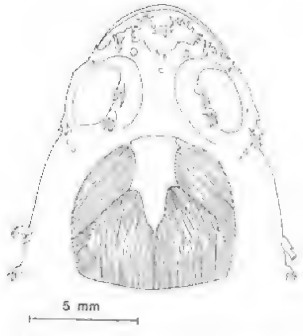

FIGURE 14. Head of *Vladichthys gloverensis* (from Greenfield 2006)

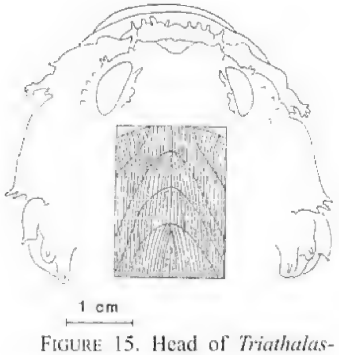

FIGURE 15. Head of *Triathalassothia argentinus* (from Greenfield 2006)

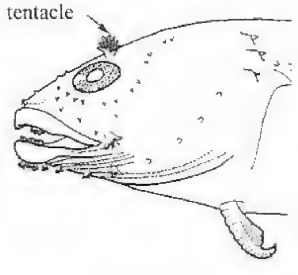

FIGURE 16. Supraorbital tentacle. Courtesy of FAO.

FIGURE 17. Head of *Halophryne*. Courtesy of FAO.

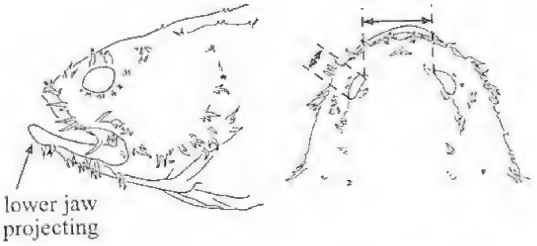

FIGURE 18. Head of *Allenbatrachus*. Courtesy of FAO.

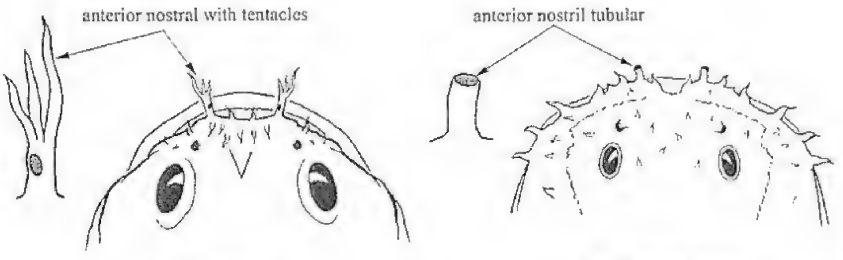

FIGURE 19. Nostrils of : a. *Chatrabus;* b. *Batrachoides*. Courtesy of FAO.

Subfamily Porichthyinae

Two solid dorsal-fin spines with no venom glands, subopercular spines absent, canine teeth present.

Genus *Aphos* Hubbs and Schultz, 1939

Aphos Hubbs and Schultz, 1939, Proc. U.S. Nat. Mus., 86 (3060):476. TYPE-SPECIES: *Batrachus porosus* Valenciennes, by original designation and monotypy.

SYNONYMS.— none.

SPECIES.— Single species, *Aphos porosus* (Valenciennes 1837), Pacific coast of South America.

DIAGNOSIS.— A member of the subfamily Porichthyinae with canines on the vomer and no photophores.

MAJOR REFERENCE.— Hubbs and Schultz (1939).

Genus *Porichthys* Girard, 1854

Porichthys Girard, C. F., 1854. Proc. Acad. Nat. Sci. Phil. 7:141–142. TYPE-SPECIES: *Porichthys notatus* Girard, 1854 by subsequent designation of Jordan and Gilbert, 1883.

SYNONYMS.— *Nautopaedium* Jordan, 1919: 342. TYPE-SPECIES: *Batrachus porosissimus* Valenciennes 1837: 501.

SPECIES.— Pacific Ocean, eight species: *P. analis* Hubbs and Schultz, 1939; *P. ephippiatus* Walker and Rosenblatt, 1988; *P. greenei* Gilbert and Starks, 1904; *P. margaritatus* (Richardson 1844); *P. mimeticus* Walker and Rosenblatt, 1988; *P. myriaster* Hubbs and Schultz, 1939; *P. notatus* Girard, 1854; *P. oculellus* Walker and Rosenblatt, 1988. Canada to Ecuador. Atlantic Ocean, five species: *P. bathoiketes* Gilbert, 1968; *P. kymosemeum* Gilbert, 1968; *P. oculofrenum* Gilbert, 1968; *P. pauciradiatus* Caldwell and Caldwell, 1963; *P. porosissimus* (Valenciennes 1837). Virginia, United States to Argentina.

DIAGNOSIS.— A member of the subfamily Porichthyinae with photophores and no canines on vomer.

MAJOR REFERENCES.— Hubbs and Schultz (1939), Gilbert (1968), Walker and Rosenblatt (1988).

Subfamily Thalassophryninae

Two dorsal-fin spines, no subopercular spines, dorsal and opercular spines hollow and connected to venom glands, canine teeth absent.

Genus *Thalassophryne* Günther, 1861

Thalassophryne Günther, 1861, Cat. Fishes v. 3: 174. TYPE-SPECIES: *Thalassophryne maculosa* Günther, 1861 by monotypy.

SYNONYMS.— *Thalassothia* Berg, 1895:66. TYPE-SPECIES: *Thalassophryne montevidensis* Berg, 1893 by monotypy.

SPECIES.— Six species, all western Atlantic: *T. amazonica* Steindachner, 1876 (freshwater); *T. maculosa* Günther, 1861; *T. megalops* Bean and Weed, 1910; *T. montevidensis* Berg, 1893; *T. nattereri* Steindachner, 1876; *T. punctata* Steindachner, 1876. Panama to Brazil.

DIAGNOSIS.— A member of the subfamily Thalassophryninae with no distinct glands present on pectoral fins; second dorsal-fin rays 17–21; anal-fin rays 16–20.

MAJOR REFERENCE.— Collette (1966).

Genus *Daector* Jordan and Evermann, 1898

Daector Jordan and Evermann, 1898, Bull. U.S. Natl. Mus. (47): 2313, 2325. TYPE-SPECIES: *Thalassophryne dowi* Jordan and Gilbert, 1887 by original designation and monotypy.

SYNONYMS.— none.

SPECIES.— Four species, all eastern Pacific: *D. dowi* (Jordan and Gilbert 1887); *D. gerringi* (Rendahl 1940); *D. quadrizonatus* (Eigenmann 1923); *D. reticulata* (Günther 1864); *D. schmitti* Collette, 1968. Costa Rica to Peru.

DIAGNOSIS.— A member of the subfamily Thalassophryninae with distinct glands located between the bases of the uppermost pectoral-fin rays; second dorsal-fin rays 22–33; anal-fin rays 21–30.

MAJOR REFERENCES.— Collette (1966, 1968, 1973).

Subfamily Batrachoidinae — New World Clade

Three dorsal-fin spines, no hollow dorsal and opercular spines connected to venom glands; one to three subopercular spines; lacks photophores and canine teeth; foramina in median process of pelvic bone; median process of pelvic bone connected to pelvic bone its entire length; upper accessory pectoral-fin radial fully ossified, medial suture between the epihyal and ceratohyal; ventral edge of cratohyal rounded where it joins epihyal; dorsal side of joint between dentary and articular about equal height and rounded; dorsal edge of quadrate flat all the way across where it meets the metapterygoid.

Genus *Amphichthys* Swainson, 1839

Amphichthys Swainson, 1839, Nat. Hist. & Class. V. 2: 184, 282. TYPE-SPECIES: *Amphichthys rubigenes* Swainson by monotypy.

SYNONYMS.— *Marcgravia* Jordan, 1887, TYPE-SPECIES: *Batrachus cryptocentrus* Valenciennes 1837, by original designation. *Marcgravichthys* Miranda-Ribeiro, 1915, TYPE-SPECIES: *Batrachus cryptocentrus* Valenciennes 1837, type by being a replacement name.

SPECIES.— One species, Atlantic: *A. cryptocentrus* (Valenciennes 1837). North coast of South America, from Panama to Brazil.

DIAGNOSIS.— A member of the subfamily Batrachoidinae lacking scales; no axillary foramen or pocket, one subopercular spine and one filament; 28–29 dorsal-fin rays; teeth short and blunt; a prominent plumose supraorbital tentacle present; venetian blind gland in pectoral-fin axil in adults.

MAJOR REFERENCE.— Greenfield and Greenfield (1973).

Genus *Batrachoides* Lacepède, 1800

Batrachoides Lacepède, 1800, Hist. nat. poissons, vol. 2: 451. TYPE-SPECIES: *Batrachoides tau* Lacepède, = *Batrachus surinamensis* Bloch and Schneider, not *Gadus tau* Linnaeus, by subsequent designation of Jordan and Evermann, 1896:466.

SYNONYMS.— *Batrictius* Rafinesque, 1815.

SPECIES.— Nine species: *B. boulengeri* Gilbert and Starks, 1904; *B. gilberti* Meek and Hildebrand, 1928; *B. goldmani* Evermann and Goldsborough, 1902; *B. liberiensis* (Steindachner 1867); *B. manglae* Cervigón, 1964; *B. pacifici* (Günther 1861); *B. surinamensis* (Bloch and Schneider 1801); *B. walkeri* Collette and Russo, 1981; *B. waltersi* Collette and Russo, 1981. Pacific, Mexico to Peru; W. Atlantic, Mexico to Brazil; freshwater (Central America); and E. Atlantic, Senegal to Angola.

DIAGNOSIS.— A member of the subfamily Batrachoidinae with scales; no foramen or funnel-shaped pocket in pectoral-fin axil; 2–19 glands present between fin rays; anal-fin rays 19–27; subopercle with two spines and one filament.

MAJOR REFERENCE.— Collette and Russo (1981).

Genus *Opsanus Rafinesque*, 1818

Opsanus Rafinesque, 1818, Am. Monthly Mag. Crit. Rev. 2(3):203. TYPE-SPECIES: *Opsanus cerapalus* Rafinesque by original designation.

SYNONYMS.— None.

SPECIES.— Six species: *O. beta* Goode and Bean, 1880; *O. brasiliensis* Rotundo, Spinelli, and Zavala-Camin, 2005; *O. dichrostomus* Collette, 2001; *O. pardus* Goode and Bean, 1880; *O. phobetron* Walters and Robins, 1961; *O. tau* (Linnaeus 1766). Gulf of Maine, United States south to Belize, including Bahamas and Cuba, and a disjunct species in São Paulo, Brazil.

DIAGNOSIS.— A member of the subfamily Batrachoidinae lacking scales; axillary foramen near center of pectoral-fin axil; one subopercular spine and one filament; dorsal-fin rays 23–27; anal-fin rays 19–23; discrete glands present between upper rays on posterior surface of pectoral fin.

MAJOR REFERENCES.— Walters and Robins (1961), Collette (2001, 2003).

DISCUSSION.— *Opsanus brasiliensis* was described from São Paulo, Brazil (Rotundo et al. 2005) far south of the distribution other species in the genus (Collette 2003). It is apparently very similar to *O. beta*, differing only in color. We have not been able to examine specimens of this species and think it is probably based on an introduction from the Gulf of Mexico.

Genus *Potamobatrachus* Collette, 1995

Potamobatrachus Collette, 1995, Ichthyol. Explor. Freshwaters, 6(4):334. TYPE-SPECIES: *Potamobatrachus trispinosus* Collette, 1995 by original designation and monotypy.

SYNONYMS.— None.

SPECIES.— One species: *P. trispinosus* Collette, 1995. Freshwater, Rio Araguaia and Rio Tocantins, Brazil.

DIAGNOSIS.— A member of the subfamily Batrachoidinae lacking scales; no axillary foramen or pocket; three subopercular spines and one filament.

MAJOR REFERENCE.— Collette (1995).

Genus *Sanopus* Smith, 1952

Sanopus Smith, 1952, Ann. Mag. Nat. Hist., ser. 12, 5:314. TYPE-SPECIES: *Opsanus barbatus* Meek and Hildebrand by original designation.

SYNONYMS.— None.

SPECIES.— Six species: *S. astrifer* (Robins and Stark 1965); *S. barbatus* (Meek & Hildebrand 1928); *S. greenfieldorum* Collette, 1983; *S. johnsoni* Collette and Stark, 1974; *S. reticulatus* Collette, 1983; *S. splendidus* Collette, Stark, and Phillips, 1974. Yucatán, Mexico south to Panama.

DIAGNOSIS.— A member of the subfamily Batrachoidinae lacking scales; axillary foramen near center of pectoral-fin axil; one subopercular spine and one filament; dorsal-fin rays 29–134; anal-fin rays 24–28; no discrete glands present on posterior surface of pectoral fin between bases of upper fin rays.

MAJOR REFERENCES.— Collette (1974, 1983, 2003).

Genus *Vladichthys*, Greenfield, 2006

Vladichthys Greenfield, 2006 Proc. Calif. Acad. Sci., ser. 4, 57(32): 946. TYPE-SPECIES: *Triathalassothia gloverensis* Greenfield and Greenfield, 1973 by original designation and monotypy.

SYNONYMS.— None.

SPECIES.— One species: *V. gloverensis* (Greenfield and Greenfield 1973). Belize and Bay Islands, Honduras.

DIAGNOSIS.— A member of the subfamily Batrachoidinae lacking scales; no axillary foramen or pocket; one subopercular spine and one filament; dorsal-fin rays 20–21; anal-fin rays 15–17; upper lateral-fine pores 15–16; lower lateral-line pores 13–19; epaxial trunk musculature not extending forward to cover entire dorsocranium behind orbits.

MAJOR REFERENCES.— Greenfield and Greenfield (1973), Collette (2003), Greenfield (2006).

Subfamily Halophryninae – Old World Clade

New subfamily, Type-genus *Halophryne* Gill, 1863

Three dorsal-fin spines; no hollow dorsal and opercular spines connected to venom glands; one to two subopercular spines and one to three filaments; lacks photophores and canine teeth; no foramina in median process of pelvic bone; median process of pelvic bone not joined to pelvic bone along its entire length; ventral edge of ceratohyal square where it joins epihyal; dorsal edge of quadrate not flat all the way across where it meets the metapterygoid.

Genus *Allenbatrachus* Greenfield, 1997

Allenbatrachus Greenfield, 1997, Pac. Sci. 51(3):307. TYPE-SPECIES: *Cottus grunniens* (Linnaeus 1758) by original designation.

SYNONYMS.— None.

SPECIES.— Three species, all Indo-Pacific: *A. grunniens* (Linnaeus 1758); *A. meridionalis* Greenfield and Smith, 2004; *A. reticulatus* (Steindachner 1870).

DIAGNOSIS.— A member of the subfamily Halophryninae with body naked; no maxillary flaps, no axillary foramen or pocket; two subopercular spines and one filament; supraorbital tentacles present; gill opening at or below pectoral-fin base; eye diameter less than snout length; interorbital width greater than eye diameter; head more pointed and flattened with lower jaw protruding;

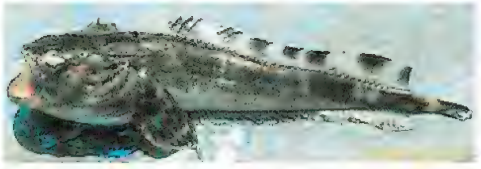

FIGURE 20. *Aphos porosus*. Photograph courtesy of R.J. Eakins.

FIGURE 21. *Porichthys notatus*. Photograph courtesy of J. Tashjian.

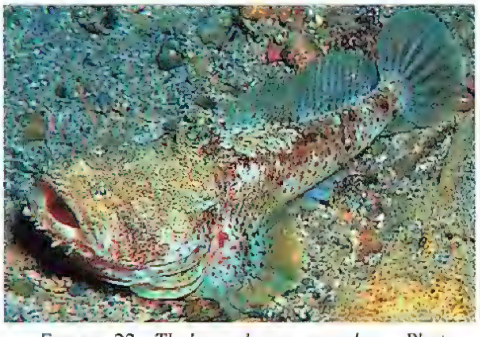

FIGURE 22. *Thalassophryne maculosa*. Photograph courtesy of P. Humann.

FIGURE 23. *Daector reticulata*. Photograph courtesy of G.R. Allen.

FIGURE 24. *Amphichthys cryptocentrus*. Photograph courtesy of J.L. Silva-Nunes.

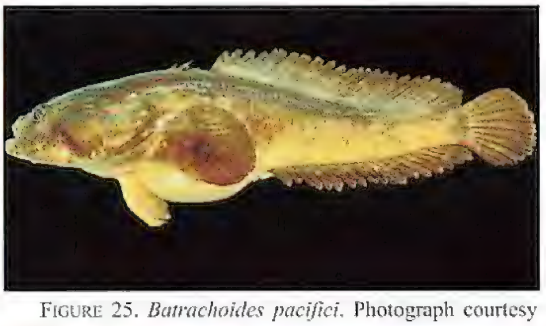

FIGURE 25. *Batrachoides pacifici*. Photograph courtesy of G.R. Allen.

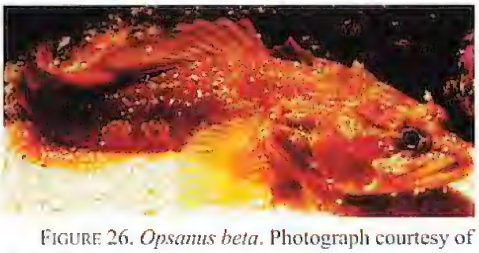

FIGURE 26. *Opsanus beta*. Photograph courtesy of S.W. Michael.

FIGURE 27. *Potamobatrachus trispinosus*. Photograph courtesy of R. Stawikowski.

FIGURE 28. *Sanopus splendidus*. Photograph courtesy of R. Whitworth.

FIGURE 29. *Vladichthys gloverensis*. Photograph by D.W. Greenfield.

epaxial trunk musculature covers entire dorsocranium; a foramen on each side of neurocranium behind eyes bordering sphenotic and frontal bones; accessory upper pectoral-fin radial totally ossified.

Major references.— Greenfield (1997), Greenfield and Smith (2004).

Genus *Austrobatrachus* Smith, 1949

Austrobatrachus Smith, 1949, Sea Fishes, 423. Type-species: *Pseudobatrachus foedus* Smith, 1947 by original designation and monotypy.

Synonyms.— None.

Species.— One species: *A. foedus* (Smith 1947). South Africa

Diagnosis.— A member of the subfamily Halophryninae lacking scales and a maxillary flap; a foramen at top of pectoral-fin axil; one subopercular spine and two filaments; supraorbital tentacles absent; anterior nasal tentacle long; dorsal-fin rays fewer than 24.

Major reference.— Smith (1952).

Genus *Barchatus* Smith, 1952

Barchatus Smith, 1952, Ann. Mag. Nat. Hist., Ser. 12, 5:332. Type-species: *Batrachus cirrhosus* Klunzinger, 1871 by original designation and monotypy.

Synonyms.— None.

Species.— One species: *B. cirrhosus* Klunzinger, 1871. Red Sea.

Diagnosis.— A member of the subfamily Halophryninae with scales extending forward to first dorsal-fin base; funnel-shaped pocket present on upper part of pectoral-fin axil; accessory pectoral-fin radial not ossified; two subopercular spines and two filaments; prominent tentacles above eyes; anterior nostril with single pointed tentacle; anal-fin rays 13–14; pectoral fin spotted.

Major reference.— Smith 1952.

Discussion.— Klunzinger (1871) described *Batrachus cirrhosus*, the only known toadfish species from the Red Sea. In 1952, Smith erected the genus *Barchatus* for that species, apparently without ever seeing a specimen. Dor (1984) then used the genus *Thalassothia* Berg (1895) for the Red Sea species, and that name has been used since (Fricke 2005), including Fish Base; however, Collette (1966) regarded the genus *Thalassothia* as a synonym of *Thalassophryne* Günther (1861), a New World genus in the subfamily Thalassophryninae. The Red Sea species is in the subfamily Halophryninae.

As stated in Eschmeyer (1998, 2008), the genus *Batrachus* (Klein 1776), used by Klunzinger (1871) to describe *B. cirrhosus*, is not available because it was published in a work that does not conform to the principle of binominal nomenclature. Prior to that, Schaeffer (1760) used the name *Batrachus*, but that publication is on the Official List of rejected works. Walbaum (1792) reprinted in a condensed form the genera of Klein, but did not accept them. D. S. Jordan (ICZN, 1910a) submitted a case to the International Commission on Zoological Nomenclature concerning the validity of Klein's genera. The Commission ruled that an earlier ruling (ICZN 1910b) on the status of pre-Linnaean names reprinted subsequent to 1757 applied, and thus the Klein names in Walbaum were not available. *Batrachus* was later used by Bloch and Schneider (1801) for *B. surinamensis*, but Collette and Russo (1981) regarded *Batrachus* as a synonym of *Batrachoides* Lacepède (1800). *Batrachus* Rafinesque (1814) is a junior synonym of the amphibian genus *Bufo* Laurenti (1768). Thus, the genus *Batrachus* is not available for the Red Sea toadfish and the valid name is *Barchatus cirrhosus*.

Figure 30. *Allenbatrachus meridionalis*. Photograph courtesy of P. Loiselle.

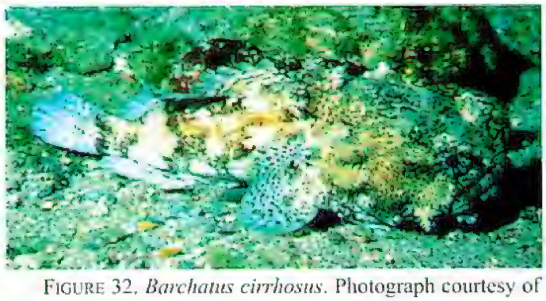

FIGURE 32. *Barchatus cirrhosus*. Photograph courtesy of E. Brokovich.

FIGURE 34. *Batrichthys apiatus*. Photograph courtesy of G. Zsilavecz.

FIGURE 36. *Chatrabus melanurus*. Photograph courtesy of P.C. Heemstra.

FIGURE 31. *Austrobatrachus foedus*. Photograph courtesy of J. Swanepoel.

FIGURE 33. *Batrachomoeus trispinosus*. Photograph courtesy of J.E. Randall.

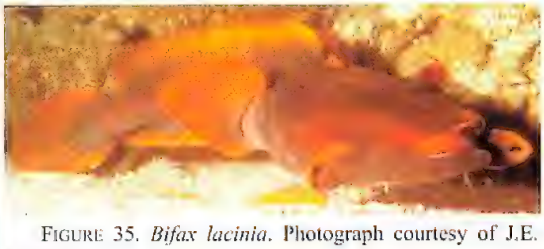

FIGURE 35. *Bifax lacinia*. Photograph courtesy of J.E. Randall.

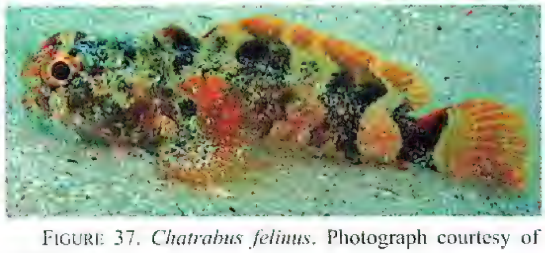

FIGURE 37. *Chatrabus felinus*. Photograph courtesy of G. Zsilavecz.

Genus *Batrachomoeus* Ogilby, 1908

Batrachomoeus Ogilby, 1908, Ann. Queensl. Mus. 9(pt. 2):46. TYPE-SPECIES: *Batrachomoeus minor* Ogilby, 1908 by subsequent designation of McCulloch 1929:358.

SYNONYMS.— *Pseudobatrachus* Castelnau, 1875; *Pelophiletor* Ogilby, 1906.

SPECIES.— Five species: *B. dahli* (Rendahl 1922); *B. dubius* (Shaw 1790); *B. occidentalis* Hutchins, 1976; *B. rubricephalus* Hutchins, 1976; *B. trispinosus* (Günther 1861). Australia north through Indo-Australian Archipelago to Thailand.

DIAGNOSIS.— A member of the subfamily Halophryninae lacking scales; no maxillary flap; foramen at top of pectoral-fin axil a distinct round hole, not funnel shaped and lacking glandular tissue on ventral margin; supraorbital tentacles present and others on head; anterior nasal tentacle not elongate; lower gill opening at lower pectoral-fin base; subopercle with one strong spine and one filament.

MAJOR REFERENCE.— Hutchins (1976).

Genus *Batrichthys* Smith, 1934

Batrichthys Smith, 1934, Trans. Roy. Soc. S.A., 22:98. TYPE-SPECIES: *B. albofasciatus* Smith, by original designation.

SYNONYMS.— *Gymnobatrachus* Smith, 1949.

SPECIES.— Two species: *B. albofasciatus* Smith, 1934; *B. apiatus* Valenciennes, 1837 South African coast.

DIAGNOSIS.— A member of the subfamily Halophryninae lacking scales; no maxillary flap; no axillary foramen or pocket; two subopercular spines and one filament; 22 or fewer dorsal-fin rays; no tentacles above eye; gill opening not less than pectoral-fin base; head depressed, 17% or less SL; eye less than interorbital width.

MAJOR REFERENCE.— Smith (1952).

DISCUSSION.— *Batrichthys felinus* Smith was previously in this genus, but has been removed to *Chatrabus*.

Genus *Bifax* Greenfield, Mee and Randall, 1994

Bifax Greenfield, Mee, and Randall, 1994, Fauna Saudi Arabia 14:277. TYPE-SPECIES: *Bifax lacinia* Greenfield, Mee, and Randall, 1994 by original designation and monotypy.

SYNONYMS.— None.

SPECIES.— One species: *B. lacinia,* Greenfield, Mee and Randall, 1994. Oman, Arabian Sea.

DIAGNOSIS.— A member of the subfamily Halophryninae lacking scales; a flap with an eye spot at end of maxilla on each side of mouth.

MAJOR REFERENCE.— Greenfield, Mee, and Randall (1994).

Genus *Chatrabus* Smith, 1949

Chatrabus Smith, 1949, Sea Fishes S. A.: 423. TYPE-SPECIES: *Batrachoides melanurus* Barnard, 1927 by original designation.

SYNONYMS.— *Tharbacus* Smith, 1952. TYPE-SPECIES: *Tharbacus vanecki* Smith, 1952.

Four species: *C. damaranus* (Barnard 1927); *C. felinus* (Smith 1952); *C. melanurus* (Barnard 1927); *C. hendersoni* (Smith 1952). West Africa Angola to Namibia and South Africa.

Diagnosis.— A member of the subfamily Halophryninae with scales present or absent; no foramen or pocket in pectoral-fin axil; two subopercular spines and two or three filaments; nasal barbels present; no supraorbital tentacles; anal-fin rays 18 or fewer.

Major references.— Smith (1952), Hutchins (1986).

Discussion.— *Chatrabus felinus* was previously in the genus *Batrichthys*, but our cladistic analysis has shown that it should be moved to the genus *Chatrabus*. The genus *Batrichthys* contained three species, *B. apiatus* (=*ophiocephalus*), *B. albofasciatus*, and *B. felinus*. The pelvic fins in both *B. apiatus* and *B. albofasciatus* are short, not reaching the vent, whereas they are longer and reach the vent in *C. felinus*. *Chatrabus felinus* has a deeper head that is not depressed (20% SL or greater) versus a depressed head (17% or less SL) in *Batrichthys* species. The interorbital is wider in *Batrichthys* species (eye less than interorbital width) versus narrower in *C. felinus* (eye equal to or greater than interorbital width). The median process of the pelvic bone is short in *C. felinus* (Fig. 38 A), whereas it is long in both *Batrichthys* species (Fig. 38 B). The ventral process of the urohyal is deep and rounded in *C. felinus* (Fig. 39 A) whereas it is more slender and elongate in both *Batrichthys* species (Fig. 39 B). The distal end of the maxilla is square and its articular head rounded in *C. felinus* (Fig. 40 A), whereas the distal end is rounded and there is a gap between the anterolateral and anteromedial process of the articular head in both *Batrichthys* species (Fig. 40 B). *Chatrabus felinus* has two subopercular filaments (Fig. 41 A) whereas both *Batrichthys* species have one (Fig. 41 B). In a comparison of the length of the skull anterior to the sphenotics to the length posterior to them, *C. felinus* is shorter behind (Fig. 42 A) whereas it is longer behind in *Batrichthys* species (Fig. 42 B). Thus, *C. felinus* differs from the species in the genus *Batrichthys* in many features.

The genus *Tharbacus* Smith, based on *T. vanecki* Smith (1952), was placed in synonymy of *Chatrabus* by Hutchins 1986. The genus *Tharbacus* was distinguished from *Chatrabus* by having scales extending forward on the top of the head to the rear edge of the orbits and in advance of the pelvic-fin insertion, whereas scales did not extend this far forward in *Chatrabus* (Smith 1952). Hutchins (1986) did not consider the difference in squamation to be of sufficient sig-

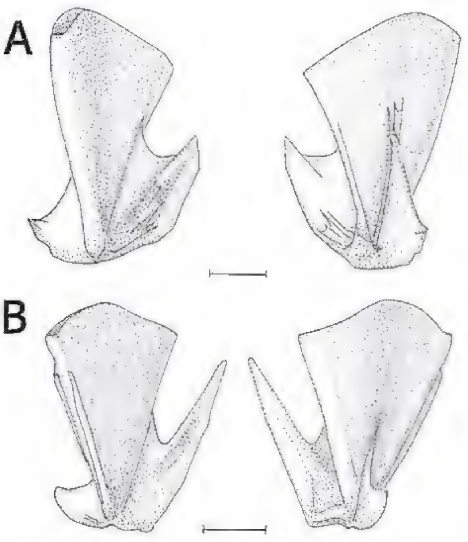

Figure 38. Pelvic bones (ventral view on right side of plate, dorsal view on left side of plate). A. *Chatrabus felinus*; B. *Batrichthys apiatus*.

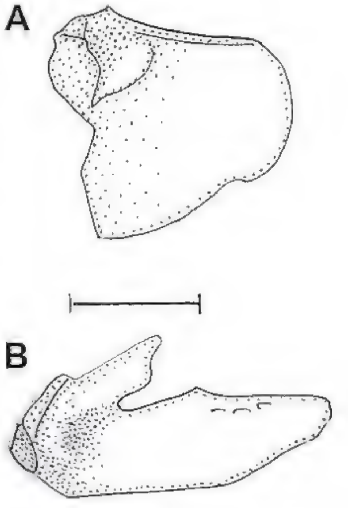

Figure 39. Urohyal (left lateral view). A. *Chatrabus felinus*; B. *Batrichthys apiatus*.

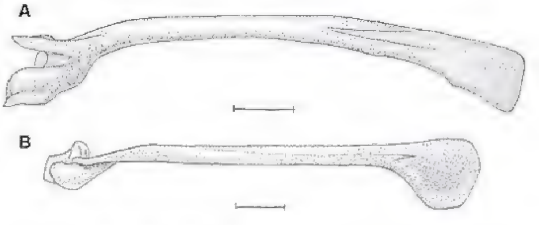

Figure 40. Maxilla (left lateral view). A. *Chatrabus felinus*; B. *Batrichthys apiatus*.

nificance to warrant generic recognition. The inclusion of *B. felinus* in the genus *Chatrabus* extends this variability to the complete loss of scales. *Chatrabus felinus* differs from the other species in the genus by lacking scales and by having two rather than three subopercular filaments. Other osteological characters agree with *Chatrabus*. The cladistic analysis placed *C. felinus* as the sister of the other two *Chatrabus* species. *Chatrabus felinus* is known only from Port Alfred and False Bay, South Africa (Penrith and Penrith 1971; Smith 1952; Winterbottom 1978).

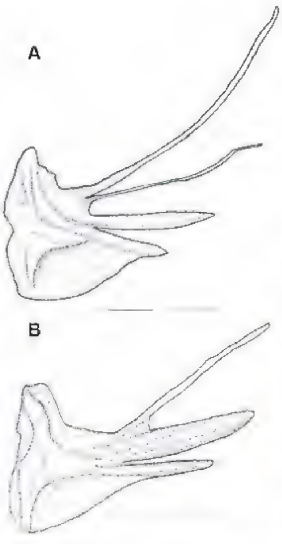

FIGURE 41. Suboperculum (left lateral view). A. *Chatrabus felinus*; B. *Batrichthys apiatus*.

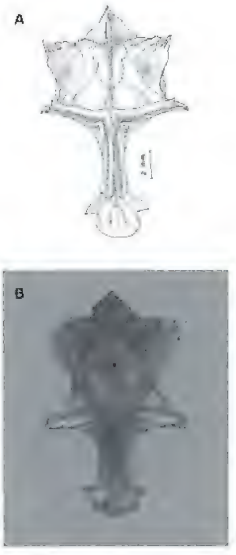

FIGURE 42. Dorsocranium. A. *Chatrabus felinus;* B. *Batrichthys apiatus*.

Genus *Colletteichthys* Greenfield, 2006

Colletteichthys Greenfield, 2006, Proc. Calif. Acad. Sci., Ser. 4, 57(32): 949. TYPE-SPECIES: *Batrachus dussumieri* Valenciennes 1837 by original designation and monotypy.

SYNONYMS.— None.

SPECIES.— One species: *C. dussumieri* (Valenciennes 1837). Arabian Gulf to India and Sri Lanka.

DIAGNOSIS.— A member of the subfamily Halophryninae lacking scales; no maxillary flaps; a funnel-shaped pit with glandular tissue inside and extending from ventral margin onto pectoral-fin axil; supraorbital tentacles present and others on head; anterior nasal tentacle not elongate; lower gill opening well below lower pectoral-fin base; subopercle with two spines, upper one large and lower one smaller and two filaments.

MAJOR REFERENCE.— Greenfield (2006).

Genus *Halobatrachus* Ogilby, 1908

Halobatrachus Ogilby, 1908, Ann. Queensl. Mus. 9(pt. 2):46, 53. TYPE-SPECIES: *Batrachus didactylus* Bloch and Schneider, 1801 by original designation

SYNONYMS.— None.

SPECIES.— One species: *H. didactylus* (Bloch and Schneider 1801). Portugal south to Angola.

DIAGNOSIS.— A member of the subfamily Halophryninae with scales; small, round foramen present on upper part of pectoral axil; one subopercular spine and two filaments; 20–21 dorsal-fin rays; no tentacles above.

MAJOR REFERENCES.— Collette, Greenfield and Costa (2006), Collette and Greenfield (in press).

Genus *Halophryne* Gill, 1863

Halophryne Gill, 1863, Proc. Acad. Nat. Sci. Phila. 15:170, TYPE-SPECIES: *Batrachoides diemensis* Lesueur, 1824 by original designation.

SYNONYMS.— *Coryzichthys* Ogilby, 1908.

SPECIES.— Four species: *H. diemensis* (Lesueur 1824); *H. hutchinsi* Greenfield, 1998;

FIGURE 43. *Colletteichthys dussumieri*. Photograph courtesy of J.E. Randall.

FIGURE 44. *Halobatrachus didactylus*. Photograph courtesy of T. Pereira.

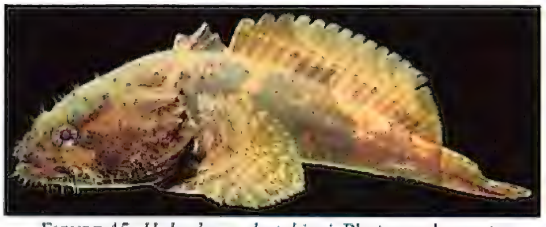

FIGURE 45. *Halophryne hutchinsi*. Photograph courtesy of K. Atack, I. Larsen, and C. Lee.

FIGURE 46. *Perulibatrachus rossignoli*. Photograph courtesy of A. Oddgeir.

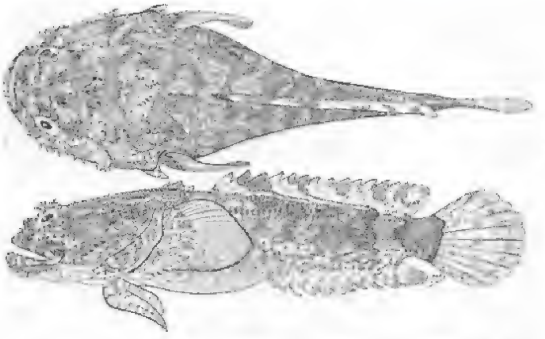

FIGURE 47. *Riekertia ellisi*. Drawing courtesy of P.C. Heemstra.

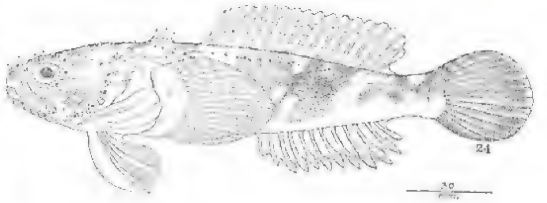

FIGURE 48. *Triathalassothia argentinus*. From Fowler (1943, figs. 23–25 of *T. devincenzii*).

H. ocellatus Hutchins, 1974; *H. queenslandiae* (DeVis 1882). Australia through New Guinea north to the Philippine Islands.

DIAGNOSIS.— A member of the subfamily Halophryninae lacking scales; no maxillary flaps; no axillary foramen or pocket; two subopercular spines and one filament; supraorbital tentacles present; gill opening clearly above lower margin of pectoral-fin base; head rounded with lower and upper jaws about equally terminal; eye diameter greater than snout length; interorbital width equal to or less than eye diameter; all bones of the branchial arches very slender.

MAJOR REFERENCES.— Hutchins (1976),Greenfield (1998).

Genus *Perulibatrachus* Roux and Whitley, 1972

Perulibatrachus Roux and Whitley, 1972, Bull. Mus. Natl. Hist. Nat. Zool. (6) [1971]:349. TYPE-SPECIES: *Batrachus elminensis* Bleeker, a replacement name for *Parabatrachus* Roux, 1971.

SYNONYMS.— *Parabatrachus* Roux.

SPECIES.— Four species: *P. aquilonarius* Greenfield, 2005; *P. elminensis* (Bleeker 1863); *P. kilburni* Greenfield, 1996; *P. rossignoli* Roux, 1957. West coast of Africa from Ghana south to Namibia; Natal, South Africa; and India.

DIAGNOSIS.— A member of the subfamily Halophryninae with scales; funnel-shaped pocket

present on upper part of pectoral-fin axil; two subopercular spines and two filaments; no obvious tentacles above eyes.

Major references.— Roux and Whitley (1972), Roux (1981), Greenfield (1996, 2005).

Genus *Riekertia* Smith, 1952

Riekertia Smith, 1952, Ann. Mag. Nat. Hist., Ser. 12, 5: 325. Type-species: *Riekertia ellisi* Smith, 1952 by monotypy and original designation.

Synonyms.— None.

Species.— One species: *R. ellisi* Smith, 1952. South Africa.

Diagnosis.— A member of the subfamily Halophryninae with scales restricted to posterior half of body; a funnel-shaped pocket present on upper part of pectoral-fin axil; two subopercular spines and three filaments; accessory pectoral-fin radial totally ossified; prominent tentacles above eye; anterior nostril with large tuft of tentacles; anal-fin rays 15–17; pectoral fin without spots.

Major reference.— Smith (1952).

Discussion.— Although differing in osteological characters, *R. ellisi* is very similar externally to *Barchatus cirrhosus* from the Red Sea. Both species have very broad, depressed heads; a deep pit in the upper portion of the pectoral-fin axil with a venetian blind-like gland below; much glandular tissue on the body under the pectoral fin; three well developed cirri above the eye; patches of small cirri on the head behind the eye; and a body with scales. The only external differences between the two species are the extent of squamation on the sides of the body, the number tentacles on the anterior nostril, the number of anal-fin rays, and the pigmentation of the pectoral fin.

Genus *Triathalassothia* Fowler, 1943

Triathalassothia Fowler, 1943, Proc. Acad. Nat. Sci. Phila. 95:330. Type-species: *T. devincenzii* (= *T. argentina*) by original designation and monotypy.

Synonyms.— None.

Species.— Two species: *T. argentina* (Berg 1897); *T. lambaloti* Menezes and Figueiredo, 1998. Brazil and Argentina.

Diagnosis.— A member of the subfamily Halophryninae lacking scales; no maxillary flaps; no axillary foramen or pocket; one subopercular spine and two filaments; dorsal-fin rays 14–17; anal-fin rays 11–13; upper lateral-line pores 23–31; lower lateral-line pores 13–19; epaxial trunk musculature extending forward to cover entire dorsocranium behind orbits.

Major references.— Greenfield and Greenfield (1973), Menezes and Figueiredo (1998).

Osteology

Illustrations of the overall osteology are presented here, whereas illustrations of specific bones mentioned in various character states are presented in the Phylogenetic Analysis section. Most of the illustrations are of a paratype of *Potamobatrachus trispinosus*, USNM 330064, 48.0 mm SL, unless otherwise noted, and were drawn by S.G. Monden, with some enhancements by Greenfield and Winterbottom. Figures 49–59.

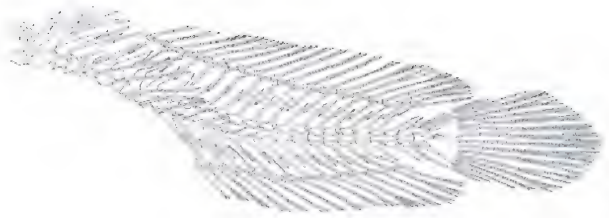

FIGURE 49. Axil skeleton of *Potamobatrachus trispinosus* (left lateral view).

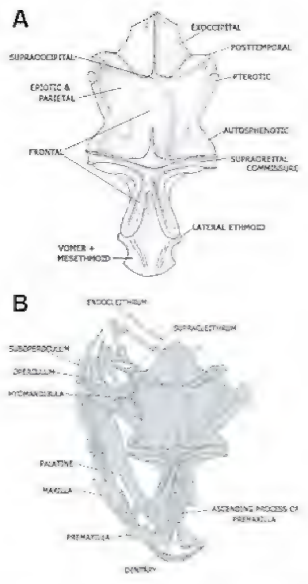

FIGURE 50. Dorsal view of head of *Potamobatrachus trispinosus*.

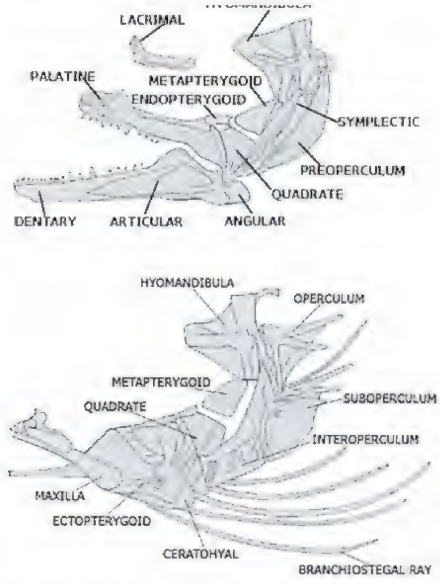

FIGURE 51. Schematic left lateral view of head skeleton of *Potamobatrachus trispinosus*, opercular series removed from upper figure.

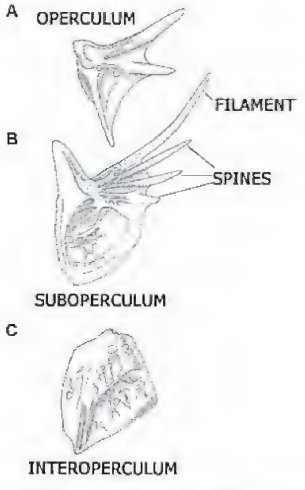

FIGURE 52. Opercular series of *Potamobatrachus trispinosus* (left lateral view).

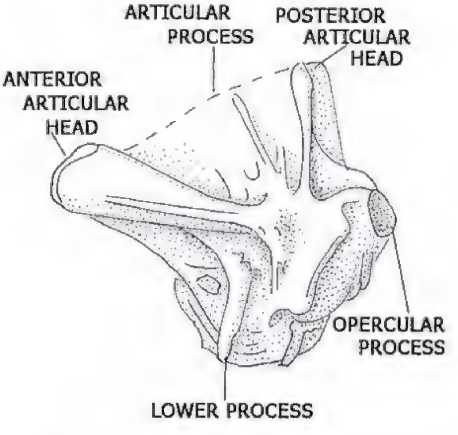

FIGURE 53. Hyomandibula of *Potamobatrachus trispinosus* (left lateral view).

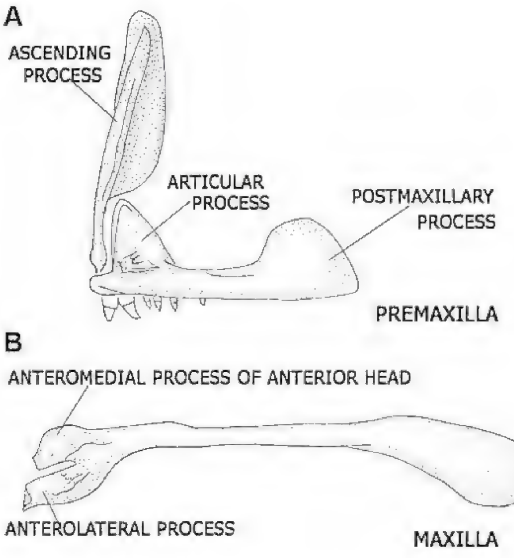

FIGURE 54. Maxilla and premaxilla of *Potamobatrachus trispinosus* (left lateral view).

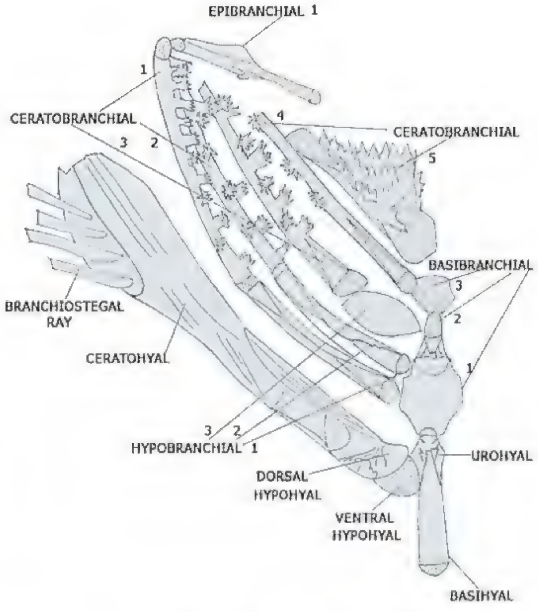

FIGURE 55. Branchial basket of *Potamobatrachus trispinosus* (left ventral portion in dorsal view; dorsal portion in ventral view).

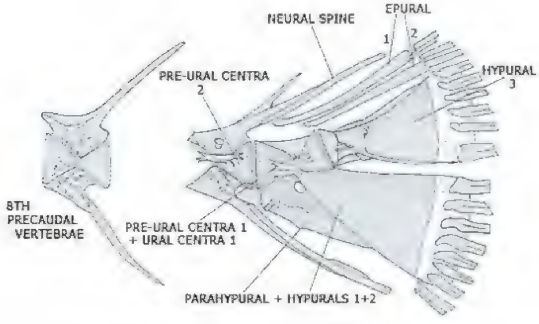

FIGURE 56. Caudal fin and eighth precaudal vertebrae of *Potamobatrachus trispinosus* (left lateral view).

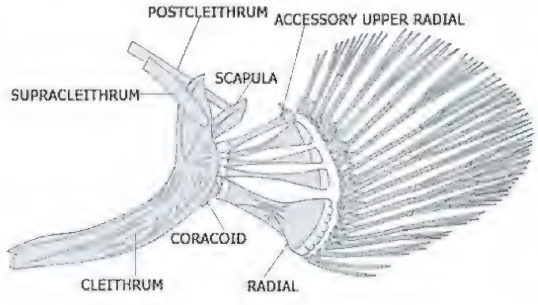

FIGURE 57. Pectoral girdle of *Potamobatrachus trispinosus* (left lateral view).

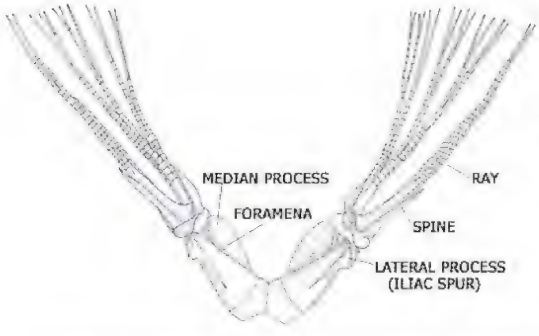

FIGURE 58. Pelvic girdle of *Potamobatrachus trispinosus* (left lateral view).

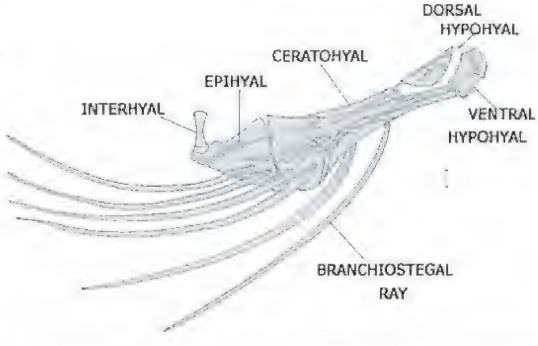

FIGURE 59. Hyoid apparatus of *Chatrabus hendersoni* SAIAB 8611 (left lateral view). Scale equals 1 mm.

Phylogenetic Analysis

The outgroup taxa chosen for the present analysis are discussed in the Methods section under Phylogenetic Analytical Methods. Many of the nodes in most of the trees are poorly supported (Bremer Support = 1), and the trees are poorly resolved. In almost all cases, there are numerous putative apomorphies (n) per node listed in the apomorphy list generated by PAUP, but the next most parsimonious tree(s) has(have) n-1 such apomorphies. We believe that these results are a function of the number of ingroup taxa (25) versus the number of informative characters in the data set (50). Consequently, we have chosen to present only the two most completely resolved trees here. These are the strict consensus trees using a) *Draconetta* and b) *Raniceps* + *Synchiropus* as the outgroups. We note, however, that several putative monophyletic subgroups appear in all, or many, of the total number of analyses conducted.

Toadfish Characters

Character Data Set

[1] Two dorsal-fin spines: 0 = no; 1 = yes.
[2] Dorsal-fin spines hollow: 0 = no; 1 = yes.
[3] Number of subopercular spines present: 0 = none; 1 = one; 2 = two; 3 = three.
[4] Scales present: 0 = absent; 1 = present.
[5] Upper accessory pectoral-fin radial cartilage: 0 = ossified; 1 = not ossified (Fig. 60).
[6] Medial suture between epihyal and ceratohyal: 0 = no; 1 = yes (Fig. 61).
[7] Foramina in skull behind eyes: 0 = no; 1 = yes (Fig. 62).
[8] Upper accessory pectoral-fin radial expanded and wide: 0 = no; 1 = yes (Fig. 60).
[9] Pectoral pore (foramina) in center of pectoral-fin axil: 0 = no; 1 = yes.
[10] Exposed bone on top of skull: 0 = no; 1 = yes (Fig. 14).
[11] Pectoral pore (foramina) top of pectoral-fin axil: 0 = no; 1 = yes (Fig. 8).
[12] Funnel-shaped pit at top of pectoral-fin axil: 0 = no; 1 = yes (Fig. 12).
[13] Ceratohyal width of expanded end equal to depth of center of ceratohyal: 0 = equal; 1 = greater.
[14] Ceratohyal at lower joint with epihyal square or round: 0 = square; 1 = round.
[15] Ceratohyal depth- depth into length of ceratohyal. 0 = 2.7; 1 = 5.3–6.4; 2 = 6.8–7.9; 3 = 8.0–8.9; 4 = 9.2–9.8; 5 = 10.6–11.9; 6 = 13.7–15.8.
[16] Maxillary flange: 0 = absent; 1 = present (Fig. 63).
[17] Maxilla bent and flange high and narrow at bend: 0 = present; 1 = absent (Fig. 64).
[18] Anterior pointing hook at distal end of maxilla: 0 = absent; 1 = present (Fig. 65).
[19] Length of premaxilla into length of maxilla: 0 = very short - 2.4–2.7; 1 = short - 2.0–2.1; 2 = medium - 1.5–1.9; 3 = long - 1.2–1.4.
[20] Shape of postmaxillary process on premaxilla: 0 = short, rounded, and symmetrical; 1 = short, rounded but not symmetrical; 2 = pointed (Fig. 66).
[21] Ascending process of premaxilla into premaxillary length: 0 = longer than premaxilla - 0.7–0.9; 1 = equal or slightly longer - 1.0–1.1; 2 = medium - 1.2–1.3; 3 = short - 1.4–2.1; 4 = very short - 4.0.
[22] Articular process of premaxilla: 0 = base wider than height; 1 = less than height.
[23] Ascending process of premaxilla, width into length: 0 = short and fat - 2.3; 1 = medium width - 4.5; 2 = slender - 6.0 and greater.
[24] Shape of articular head of maxilla: 0 = rounded; 1 = no gap between anterolateral and anteromedial process; 2 = anterolateral process long and pointed; 3 = a gap between the anterolateral

and anteromedial process (Fig. 67).

[25] Pelvic bone- foramina in median process: 0 = absent Figure 38); 1 = present (Fig. 58).

[26] Pelvic bone-distance of anterior point of median process to its joining place on pelvic bone divided into pelvic-bone length: 0 = none, connected entire length; 1 = short - 5.2–10.8; 2 = medium - 3.1–5.0; 3 = long - 2.1–2.9.

[27] Pelvic bone-length of median process divided into pelvic-bone length: 0 = long - 1.1; 1 = 1.2; 2 = 1.3; 3 = 1.4; 4 = 1.5; 5 = 1.6; 6 = 1.7; 7 = short - 1.9 or >.

[28] Hyomandibula: 0 = not rounded; 1 = rounded (Fig. 68).

[29] Hyomandibula - angle of anterior articular head: 0 = anterior articular head angled up from a straight line across from opercular process;1 = anterior articular head in a straight line across from the opercular process (Fig. 68).

[30] Hyomandibula - lower process: 0 = square (Figure 68); 1 = round (Fig. 53).

[31] Angular - shape of distal end: 0 = slant posterior, about 65 degrees - bump and cup present; 1 = slant posterior, about 80–82 degrees - bump present; 2 = slant posterior, about 65 degrees - bump rounded; 3 = straight up no bump or cup; 4 = rounded and symmetrical; 5 = straight up- small bump sticks out; 6 = slants forward 98–103 degrees; 7 = slants more forward, 109–112 degrees, deep cup (Fig. 69).

[32] Lower jaw-joint of dentary and articular - dorsal side: 0 = dentary highest, pointed and triangular - often gap (Fig. 69C); 1 = dentary highest, but rounded; 2 = about equal height and rounded (Fig. 70A); 3 = dentary only at high point, articular reduced, triangular (Fig. 70B); 4 = dentary highest, and flat (Fig. 70C); 5 = articular higher, and pointed (Fig. 69A).

[33] Dentary shape: 0 = bent down with no tip (Fig. 69C); 1 = sharp bend down with obvious tip down at end (Fig. 70C); 2 = straight with obvious tip at end; 3 = straight, no tip at end; 4 = curved up (Fig. 69A).

[34] Extent of endopterygoid onto quadrate: 0 = extends well up onto or past quadrate (Fig. 71A); 1 = does not extend onto quadrate (Fig. 71B).

[35] Ectopterygoid attachment to quadrate: 0 = full anterior face attached (Fig. 71A); 1 = top notch on anterior face only (Fig. 71B).

[36] Quadrate shape: 0 = flat on top all the way across where it meets metapterygoid Fig. 71A); 1 = part flat at top, but is trangular shaped; 2 = top rounded, fan-like shape (Fig. 71B).

[37] Flange on anterodorsal face of metapterygoid; 0 = absent (Figure

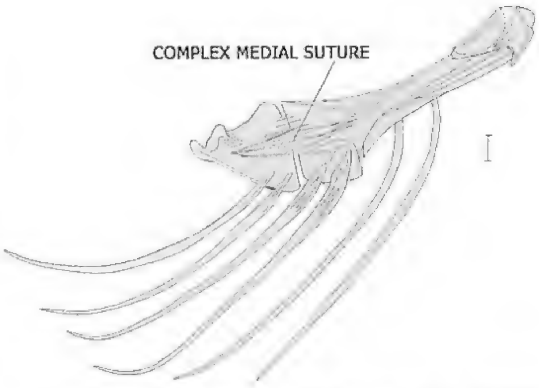

FIGURE 61. Hyoid apparatus of *Riekertia ellisi* SAIAB 12738 showing complex medial suture (left lateral view).

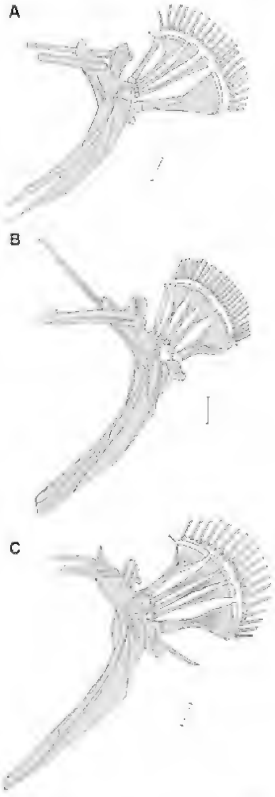

FIGURE 60. Upper accessory pectoral-fin radial character states (left lateral view). A. *Batrachoides gilberti* (FMNH 84549), fully ossified and not expanded; B. *Halobatrachus didactylus* (USNM 205066), not ossified and not expanded; C. *Porichthys notatus*, (CAS 223822), fully ossified and expanded. Scale equals 2 mm.

72B), 1 = present (Fig. 72A).

[38] Shape of dorsal end of metapterygoid: 0 = single head, straight up, no hook or bend; 1 = double head straight up (Fig. 72A); 2 = narrow club-shaped with slight anterior bend; 3 = sharp angle anteriorly and narrow (Fig. 71B); 4 = narrow sharp sickle-shaped point- anterior; 5 = small, broad anterior hook; 7 = anterior curve, multi points.

[39] Number of subopercular filaments: 0 = absent; 1 = one (Fig. 41); 2 = two (Fig. 41); 3 = three.

[40] Opercular spine number: 0 = two; 1 = one.

[41] Width into length of urohyal: long, 0 = 1.1 or >; 1 = short 1.0 or <.

[42] Hypobranchial III, number of heads: 0 = 2 heads (Fig. 73A); 1 = one head (Fig. 73B).

[43] Hypobranchial III, shape of anterior end: 0 = square (Fig. 74A); 1 = rounded (Fig. 74B); 2 = narrow point (Fig. 74C); 3 = wide point (Fig. 74D); 4 = reduced different from preceding (Fig. 74E).

[44] Hypobranchial I, shape of narrower anterior end: 0 = flat (Figure 75A); 1 = spine (Fig. 75B).

[45] Epibranchial I, length of uncinate process compared to length of proximal end of epibranchial (where pharyngobranchial I would attach) measured from base of uncinate process: 0 = distal end of epibranchial longer than uncinate process; 1 = both symmetrical; 2 = uncinate process twice as long as distal end of epibranchial; 3 = same as 2, but with no bump-like expansion on medial side of epibranchial; 4 = distal end of epibranchial very short and directed towards pharyngobranchial II, and uncinate long and straight; 5 = distal end of epibranchial very short, but directed laterally, and uncinate long and straight; 6 = distal end of epibranchial pointed towards ceratobranchials, and uncinate long and straight.

[46] Sphenotic shape on side of skull; 0 = cut in towards center of skull (Fig. 76A); 1 = straight and flat (Fig. 76B).

[47] Interorbital width divided by skull width at sphenotics: 0 = narrow, 5.1–7.5; 1 = medium, 3.4–5.0; 2 = wide, 1.1–3.3.

[48] Skull width at sphenotics into length: 0 = wide - 1.3–1.5; 1 = narrower- 1.6 or > .

[49] Comparison of length of skull in front of sphenotics to length in back: 0 = front greater than back, 1 = front equals back, 2 = front less than back.

[50] Caudal fin- shape of parhypural: 0 = anteroventral surface flat against neural spine for short distance and then up posteriorly abruptly; 1 = anteroventral surface broad, gentle, concave curve; 2 = anteroventral surface broad, gentle, convey curve up to anterior bend; 3 = anteroventral surface gently concave with double points at bend; 4 = anteroventral surface short and rounded with single spine, parhypural very narrow; 5 = anteroventral surface straight to slightly concave, parhypural very narrow, almost missing; 6 = anteroventral surface with radiating spines.

The data set is presented with character distributions in tabular form in Table 1.

Results.— The two consensus trees are given in Fig. 77 (*Draconetta* as outgroup – hereafter referred to as 'D') and Fig. 78 (*Raniceps* + *Synchiropus* as outgroups –'RS'). Figure 79 gives the visual concensus of these two trees. Several clades are present in both trees. In the ensuing discussion, putative apomorphies (hereafter referred to as 'PAs') in both PAUP analyses are listed along with the character state changes at that node. Unambiguous synapomorphies are referred to as unreversed, or listed with a CI of 1. References to the characters in the character data set list above will be referred to as '# X'.

The uppermost clade in the figures links six of the ten New World taxa, *Opsanus* through *Vladichthys*, in a monophyletic group. The D analysis lists four PAs supporting the clade, the RS has five. While there are no characters common to the two lists, the change in state of # 32 in the

TABLE 1. Data Matrix for Toadfish taxa with *Raniceps*, *Synchiropus* and *Draconetta* as outgroups

Taxa/Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
Amphichthys cryptocentrus	0	0	1	0	0	1	0	0	0	1	0	0	1	0	2	1	0	0	0	0	0	0	2	1	1	0	0	0	1	1	4	2	3	0	0	0	1	0	1	1	0	1	2	0	3	1	1	1	1	2
Aphos porosus	1	0	0	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	3	2	3	1	2	2	1	0	1	0	0	0	5	5	2	0	0	0	1	5	2	0	0	1	3	0	2	0	1	0	0	6
Daector reticulata	1	1	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	0	1	1	1	0	2	1	1	0	2	1	1	1	7	5	4	0	0	0	1	0	2	0	0	1	3	0	5	0	0	0	0	3
Batrachoides gilberti	0	0	2	1	0	1	0	0	0	0	0	0	1	1	5	1	0	0	0	1	0	0	2	1	1	0	0	0	1	1	4	2	3	0	0	0	1	4	1	1	0	1	2	0	2	0	1	1	1	0
Opsanus tau	0	0	1	0	0	1	0	0	1	0	0	0	1	1	4	1	0	0	1	0	0	0	2	1	1	0	0	0	0	1	4	2	3	0	0	0	1	1	1	1	0	1	2	0	2	0	1	1	0	4
Potamobatrachus trispinosus	0	0	3	0	0	1	0	0	0	0	0	0	1	1	2	0	0	0	2	1	1	0	1	3	1	0	0	0	1	1	4	2	3	0	0	0	1	0	1	1	0	1	2	0	5	0	2	1	1	2
Porichthys notatus	1	0	0	0	0	1	0	1	0	0	0	0	0	1	1	0	0	0	3	2	3	1	2	2	1	0	2	0	0	0	5	5	2	0	0	1	1	5	2	0	1	1	3	0	2	0	1	0	0	6
Sanopus barbatus	0	0	1	0	0	1	0	0	1	1	0	0	1	1	2	1	0	0	1	0	1	0	2	1	1	0	0	0	1	1	4	2	3	0	0	0	1	1	1	1	0	1	2	0	2	1	2	1	1	2
Thalassophryne megalops	1	1	0	0	0	1	0	0	0	0	0	0	1	1	1	1	1	0	1	1	2	0	2	1	1	0	1	1	0	1	7	5	4	0	0	0	1	0	2	0	0	0	2	0	5	0	0	0	2	2
Vladichthys gloverensis	0	0	1	0	0	1	0	0	0	1	0	0	1	0	3	1	0	0	1	0	1	0	2	1	1	0	2	0	1	1	4	2	3	0	0	0	1	7	1	1	0	1	2	0	1	1	1	1	2	0
Triathalassothia argentinus	0	0	1	0	1	0	0	0	0	0	0	0	1	0	4	0	0	0	2	2	2	0	2	3	0	2	4	0	0	0	0	0	0	0	0	1	1	6	2	1	0	1	1	1	1	0	0	0	0	2
Allenbatrachus grunniens	0	0	2	0	0	1	1	0	0	0	0	0	1	0	5	1	0	0	1	1	0	0	2	3	0	2	5	0	1	0	6	3	2	1	1	1	1	0	1	1	1	0	0	0	1	0	2	1	2	0
Austrobatrachus foedus	0	0	1	0	1	1	0	0	0	0	0	1	1	0	3	0	0	0	2	2	3	0	2	3	0	3	3	0	1	0	1	0	1	1	1	2	0	3	2	1	1	1	1	1	4	0	1	0	2	1
Barchatus cirrhosus	0	0	2	0	0	1	0	0	0	0	0	1	1	0	3	0	0	0	2	2	3	0	2	3	0	3	3	0	1	0	6	0	2	1	1	2	0	3	2	1	1	1	2	1	4	0	1	0	0	5
Rickertia ellisi	0	0	2	0	1	1	0	0	0	0	0	1	1	0	3	0	0	0	2	2	1	0	2	3	0	3	1	0	1	0	6	0	2	1	1	2	0	3	3	1	1	1	0	1	4	0	1	0	0	5
Batrachomoeus trispinosus	0	0	1	0	0	1	1	0	0	0	1	0	1	0	2	1	0	0	2	1	1	0	2	3	0	1	7	0	0	0	6	3	2	1	1	1	1	4	1	1	0	1	2	0	6	0	1	0	2	0
Chatrabus felinus	0	0	2	0	0	0	0	0	0	0	0	0	1	0	3	0	0	1	2	2	3	0	2	3	0	1	6	0	0	0	1	0	2	1	1	2	0	4	2	1	1	1	2	1	2	0	0	0	0	0
Batrichthys apiatus	0	0	2	0	1	0	0	0	0	0	0	0	1	0	5	0	0	0	2	2	3	0	2	0	0	3	2	0	1	0	1	1	1	1	0	2	0	3	1	1	0	1	2	1	2	0	1	0	2	5
Bifax lacinia	0	0	2	0	0	1	0	0	0	0	0	0	1	0	5	0	0	0	2	2	2	0	2	3	0	2	4	0	1	1	4	0	2	1	1	2	0	2	1	1	1	1	2	0	4	0	2	0	2	0
Chatrabus hendersoni	0	0	2	1	0	0	0	0	0	0	0	0	1	0	3	0	0	1	2	2	1	0	2	3	0	2	4	0	1	0	1	0	1	1	1	2	0	3	3	1	1	1	2	1	2	0	0	0	0	1
Chatrabus melanurus	0	0	2	1	0	0	0	0	0	0	0	0	1	0	3	0	0	1	2	2	2	0	2	3	0	3	7	0	1	0	1	0	1	1	1	2	0	3	3	1	1	1	2	1	2	0	0	0	0	1
Colletteichthys dussumieri	0	0	2	0	0	1	0	0	0	0	0	1	1	0	6	0	0	0	2	1	2	0	2	3	0	2	5	0	0	0	6	0	2	1	1	2	0	3	2	1	1	1	2	1	4	0	0	0	0	0
Halobatrachus didactylus	0	0	1	1	1	1	0	0	0	0	1	0	1	0	4	0	0	0	2	2	2	0	2	3	0	3	3	0	0	0	3	4	1	1	1	2	0	3	2	1	1	1	1	1	4	0	1	0	0	3
Halophryne diemensis	0	0	2	0	0	1	1	0	0	0	0	0	1	0	4	0	0	0	0	2	0	0	2	0	0	2	6	0	1	1	2	3	2	1	1	1	1	0	1	1	1	1	4	0	1	0	0	0	0	0
Perulibatrachus elminensis	0	0	2	1	1	1	0	0	0	0	0	1	1	0	5	0	0	0	2	2	3	0	2	3	0	3	2	0	1	0	3	4	1	1	1	2	0	2	2	1	1	0	0	0	4	0	2	0	2	0
Synchiropus atrilabiatus	0	0	0	0	-	0	0	-	0	0	0	0	1	0	1	0	0	0	3	1	0	0	2	3	0	0	4	0	1	0	0	0	1	1	0	?	1	?	1	?	0	1	0	0	4	0	0	0	0	2
Raniceps raninus	0	0	0	1	-	0	0	-	0	0	0	0	1	0	0	0	0	0	3	1	4	0	0	0	?	?	?	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	?	?	?	?
Draconetta oregona	0	0	1	0	-	0	0	-	0	0	0	0	1	1	5	0	1	0	3	2	0	1	1	3	1	0	0	0	0	0	0	6	1	1	1	1	2	0	0	1	1	0	1	1	1	4	0	0	1	0	4

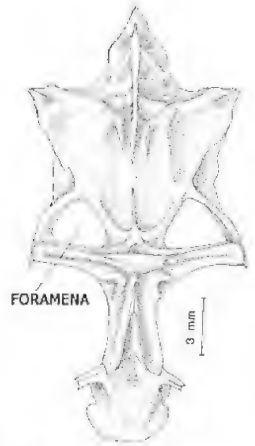

FIGURE 62. Foramina in dorsocranium of *Allenbatrachus reticulatus* CAS-SU 30658.

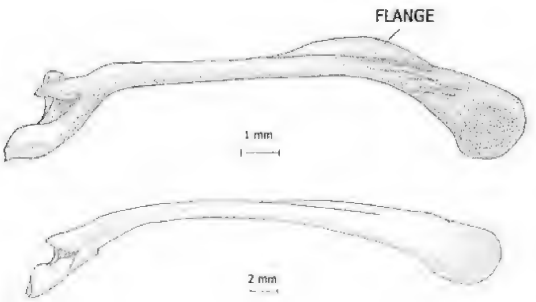

FIGURE 63. Maxilla of A. *Allenbatrachus grunniens* CAS-SU 26909 with flange; B. *Trithalassothia argentinus* USNM 214438 without flange (left lateral view).

FIGURE 64. Maxilla of *Thalassophryne maculosa* USNM 199524 with bend and flange (left lateral view).

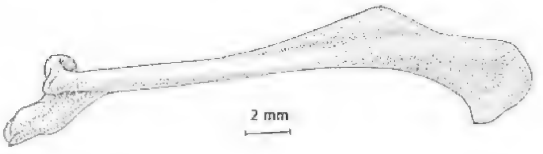

FIGURE 65. Maxilla of *Vladichthys gloverensis* FMNH 91036 with distal hook (left lateral view).

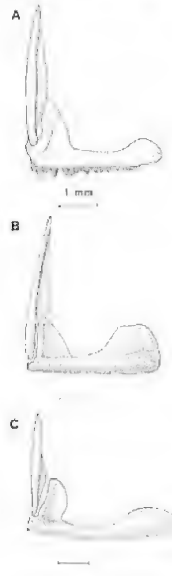

FIGURE 66. Shape of postmaxillary process of premaxilla (left lateral view). A. *Amphichthys cryptocentrus* USNM 144888, short, rounded, and symmetrical; B. *Batrachoides gilberti* FMNH 84549, short, rounded, but not symmetrical; C. *Batrichthys apiatus* SAIAB 75-25, pointed.

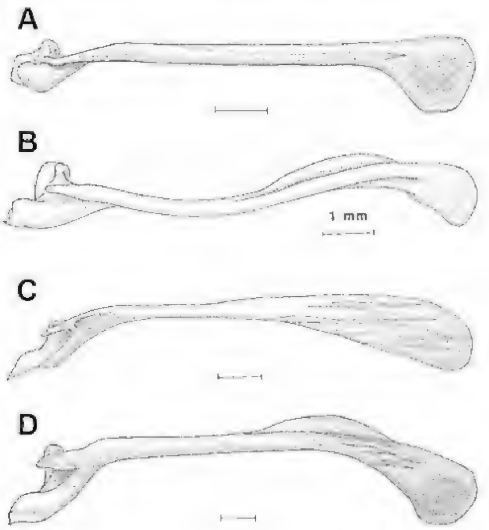

FIGURE 67. Shape of articular head of maxilla (left lateral view). A. *Batrichthys apiatus* SAIAB 75-25, rounded; B. *Amphichthys cryptocentrus* USNM 144888, no gap between anterolateral and anteromedial process; C. *Aphos porosus* CAS 65051, anterolateral process long and pointed; D. *Allenbatrachus grunniens* CAS-SU 26909, gap between anterolateral and anteromedial process.

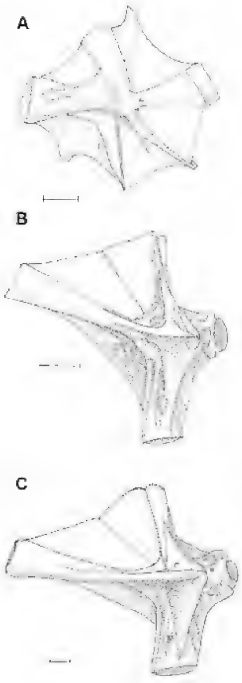

FIGURE 68. Hyomandibula (left lateral view). A. *Daector reticulata* GCRL 16194, rounded; B. *Halobatrachus didactylus* USNM 205066, not rounded, anterior articular head angled up; C. *Perulibatrachus elminensis* MNHN 1970-43, not rounded, anterior articular head straight across. Scale equals 1 mm.

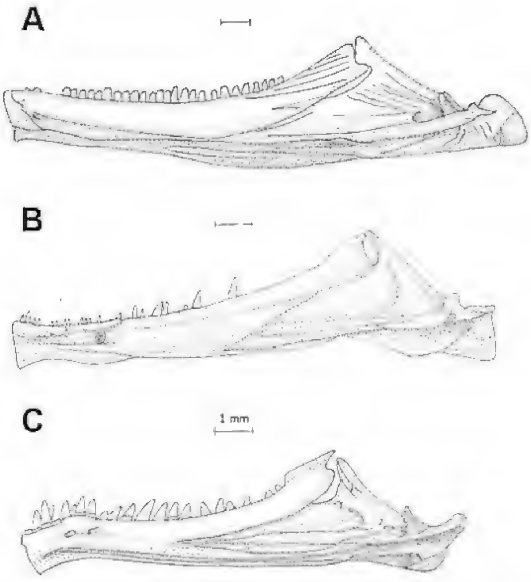

FIGURE 69. Orientation of distal end of angular (left lateral view). A. *Thalassophryne maculosa* USNM 199524, anterior; B. *Aphos porosus* CAS 65051, straight up; C. *Triathalassothia argentinus* USNM 214438, posterior.

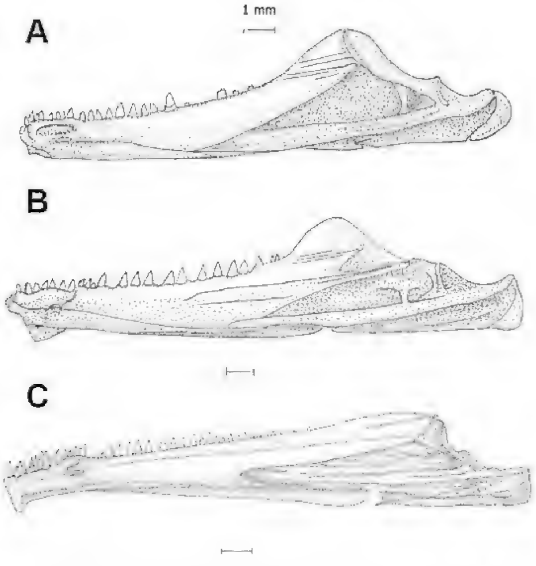

FIGURE 70. Dorsal joint of dentary and articular (left lateral view). A. *Opsanus tau* CAS 223821, equal height and rounded; B. *Allenbatrachus grunniens* CAS-SU 26909, dentary only at high point, articular reduced, triangular; C. *Halobatrachus didactylus* USNM 205066, dentary highest and flat.

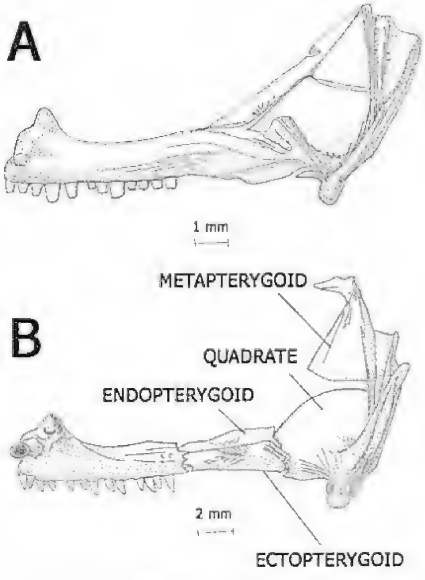

FIGURE 71. Extent of endopterygoid onto quadrate (left lateral view). A. *Amphichthys cryptocentrus* USNM 144888, extends well up onto or past quadrate; B. *Riekertia ellisi* SAIAB 12738, does not extend onto quadrate.

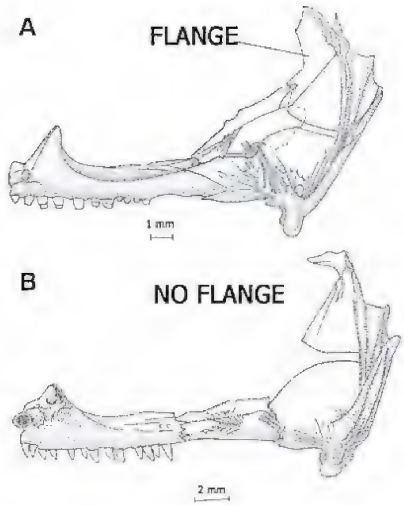

FIGURE 72. Metapterygoid flange (left lateral view). A. *Sanopus barbatus* SIO 6745, flange present; B. *Riekertia ellisi* SAIAB 12738, no flange.

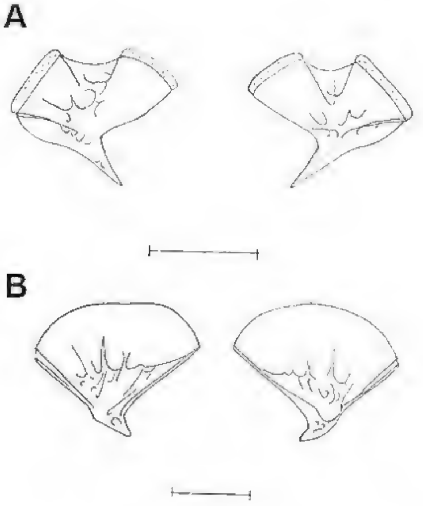

FIGURE 73. Hybobranchial III, number of heads (dorsal view of left side on right side of plate, ventral view on right side of plate). A. *Thalassophryne maculosa* USNM 199524, two heads; B. *Chatrabus felinus* SAIAB 75-25, one head. Scale equals 1 mm.

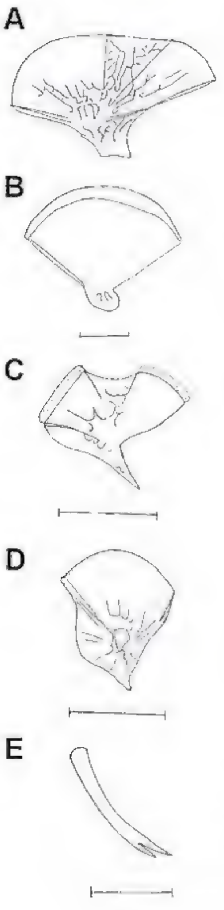

FIGURE 74. Hypobranchial III, shape of anterior end (left ventral view). A. *Perulibatrachus elminensis* MNHN 1970-43, square; B. *Triathalassothia argentnius* USNM 214438, rounded; C. *Thalassophryne maculosa* USNM 199524, narrow point; D. *Aphos porosus* CAS 65051, wide point; E. *Halophryne diemensis* NTMS 10005-019, reduced.

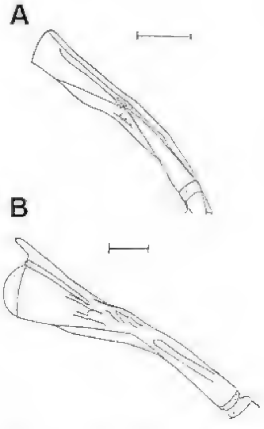

FIGURE 75. Hypobranchial 1, shape of anterior end. (Dorsal view of right side). A. *Amphichthys cryptocentrus* USNM 144888, flat; B. *Chatrabus hendersoni* SAIAB 8611, spine. Scale equal 1 mm.

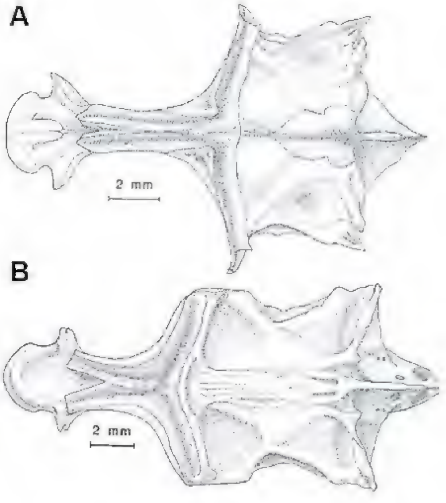

FIGURE 76. Autosphenotic shape on side of dorsocranium. A. *Chatrabus felinus* SAIAB 75-25, cut in towards center of skull; B. *Vladichthys gloverensis* FMNH 91036, straight and flat.

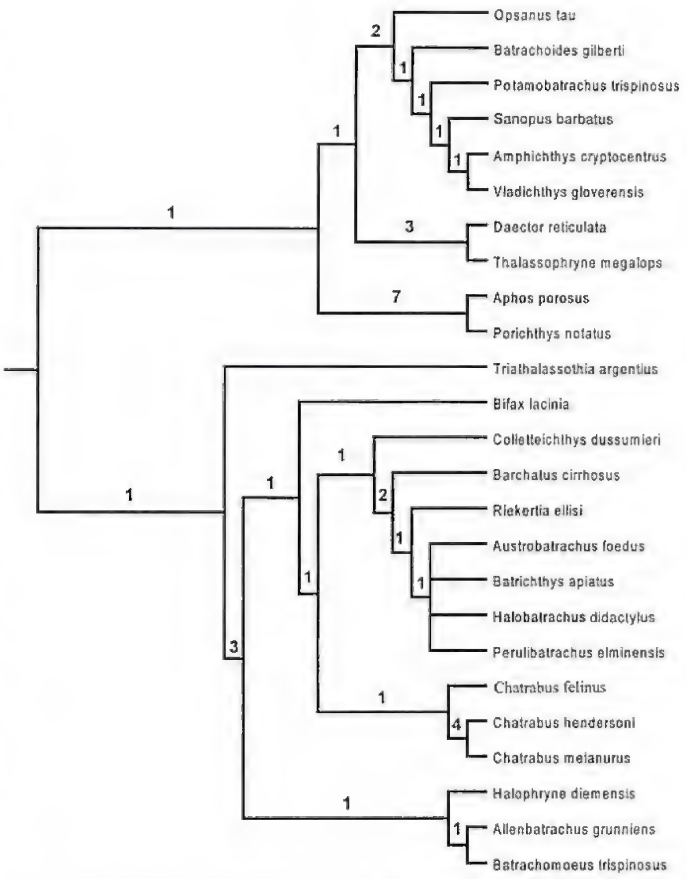

FIGURE 77. Strict consensus tree with *Raniceps* and *Synchiropus* as outgroups. Numbers above the lines represent Bremmer Support Values.

RS analysis is an unreversed synapomorphy for the clade (state 5→2). In both analyses, *Opsanus* is the first taxon to diverge, and is autapomorphic based on four character states, three of which are shared. These are the homoplastic states of #9 and #38 (both 0→1) and the unreversed state of # 50 (2→4). The remaining five genera share two putative homoplastic apomorphies in both analyses (#s 29 and 49, both 0→1). *Batrachoides*, the next taxon to diverge, is defined by the same five putative synapomorphies in both analyses, # 3 (1→2), # 4 (0→1), # 19 (1→0), # 38 (0→4) and # 50 (2→0). The four remaining taxa share two PAs in the D analysis, and one in the RS. One of these is shared between the two trees - #21 (0→1). Both analyses find *Potamobatrachus* as sister to the remaining three taxa, and defined by the same six autapomorphic states. These are # 3 (1→3), # 16 (1→0), # 19 (1→0), # 23 (2→1), # 24 (1→3), and # 45 (2→5). Of these, both analyses recognize # 3 as an unreversed autapomorphy (CI = 1) and # 23 is also accorded this status in the RS list. The other three taxa are defined by two unreversed synapomorphies in both analyses: # 10 (0→1) and # 46 (0→1), and a further homoplastic PA is listed by the RS. *Sanopus* is defined by two homoplastic states (# 9, 0→1, # 38, 0→1). *Amphichthys* and *Vladichthys* are sister groups based on a single homoplastic character state (# 14, 0→1). Two autapomorphies define *Amphichthys* (# 19, 1→0, # 21, 1→0). *Vladichthys* has five autapomorphies: # 15 (2→3), # 27 (0→2), # 38 (0→7), # 49 (1→2), and # 50 (2→0), of which only # 38 has a CI = 1.

Both analyses recognize *Aphos* and *Porichthys* as a monophyletic group based on seven putative synapomorphies, six of them common between them. These are: # 8 (0→1, CI = 1); # 13 (1→0, CI = 1); # 21 (2→3 in D, 0/2→3 in RS); # 22 (0 →1, homoplastic in D but unreversed in RS); # 38 (0→5, CI = 1); and # 50 (2→6, CI = 1). The D analysis also lists # 30 (0→1), and the RS lists # 43 (2→3). Two autapomorphies are listed in both analyses that define *Porichthys*, but both exhibit homoplasy (# 36 (0→1) and # 41 (0→1). None are given for *Aphos*. Similarly, both analyses recognize *Daector* and *Thalassophryne* as sister taxa. In the D analyses, the group is defined by eight putative synapomorphies, and three of these are unreversed: # 2 (0→1, CI = 1), # 16 (0→1), # 17 (0→1), # 20 (2→1), # 28 (0→1, CI = 1), # 30 (0→1), # 33 (2→4, CI = 1), and # 45 (2→5). The RS analysis list four of the above, three of which are unreversed (#'s 2, 17, 28 and

45, with # 17 now interpreted as unreversed).

Fifteen taxa comprise the Old World sampling, and the trees from the two analyses are identical (although the support may not be). The D analysis lists six putative synapomorphies supporting the monophyly of this group: # 14 (1→0), # 19 (1/3→2), # 25 (1→0, CI = 1), # 26 (0→2), # 36 (0→1), and # 45 (2→1). The RS lists four such characters, three of which also occur in the D analysis: (# 19 (3→2), # 26 (0→2), # 36 (0→1), and # 40 (0→1). *Triathalassothia* forms the sister group to the other 14 taxa, and is defined in the D tree seven autapomorphies: # 5 (0→1), # 6 (1→0), # 15 (5→4), # 31 (6→0, CI = 1), # 33 (2→0, CI = 1), # 38 (0→6, CI = 1), and # 44 (0→1). There are four such character states given in the RS: #'s 5, 38 and 44 as above, and # 43 (2→1). Six putative synapomorphies, none unreversed, define the remaining taxa in both trees. In D, these are: # 3 (1→2), # 29 (0→1), # 34 (0→1), # 35 (0→1), # 41 (0→1), and # 50 (2→0). The list is the same for RS, except that # 3 drops away, and # 31 (0→6) is added. There are two monophyletic subgroups in the remaining 14 taxa. *Allenbatrachus*, *Batrachomoeus* and *Halophryne* form a clade, based on # 7 (0→1, CI = 1), # 21 (2→0), and # 32 (0→3, CI = 1) in the D analysis and #s 7 and 32 in the RS. The sister group to this, the remaining taxa, is defined by three character states in the D: # 36 (1→2), # 37 (1→0) and # 45 (1→4) and by the first two in the RS, in which # 36 is unreversed. In the first clade, the first two genera form a monophyletic group based on three homoplastic character states in both analyses: # 16 (0→1), # 20 (2→1) and # 49 (0→2). *Halophryne* is defined by six autapomorphies in the D analysis: # 15 (5→4), # 19 (2→0), # 24 (3→0), # 30 (0→1), # 31 (6→2) and # 43 (2→4) and by five of the same states (# 15 absent) in the RS. Character states # 31 and # 43 have a CI of one. In both analyses, *Allenbatrachus* is characterized by four homoplastic autapomorphies: # 19 (2→1), # 42 (1→0), # 43 (2→0), and # 48 (0→1). *Batrachomoeus* is defined by eight autapomorphies in both hypotheses: # 3 (2→1), # 11 (0→1), # 21 (0→1), # 26 (0→1), # 29 (1→0), # 38 (0→4), # 41 (1→0) and # 45 (1→6, CI = 1). In addition, the D analysis lists # 15 (5→2).

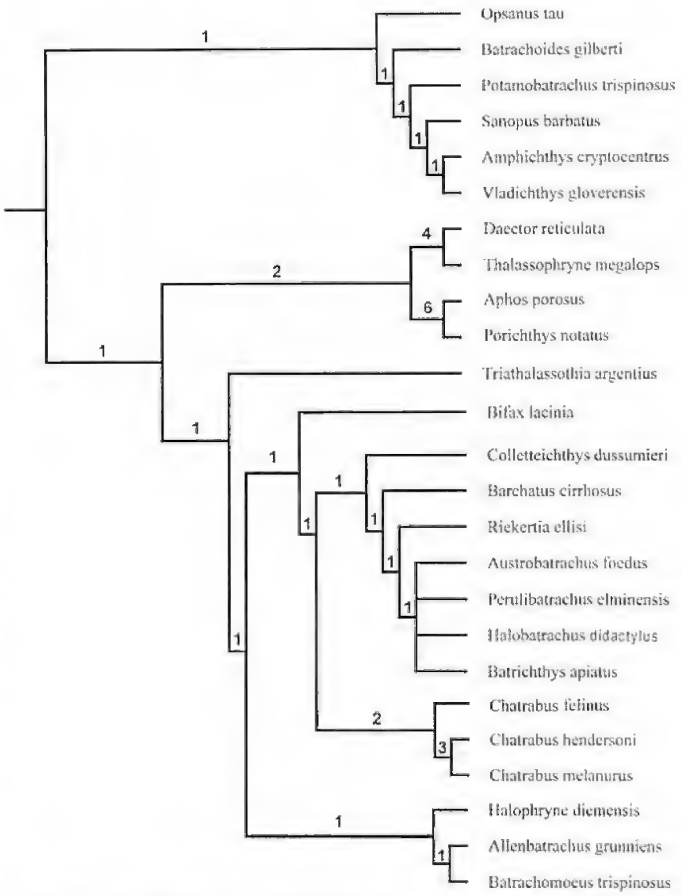

FIGURE 78. Strict consensus tree with *Draconetta* as outgroup. Numbers above the lines represent Bremmer Support Values.

The remaining clade of 11 entities is divided into *Bifax* (autapomorphies in both analyses: # 30 (0→1), # 31 (6→4), # 47 (0→2) and # 49 (0→2), and the remaining 10 taxa, defined by two homoplastic states (# 15, 5→3, and # 44, 0→1) in the D analysis and by only the second of these

in the RS. This clade is divided into two monophyletic subsets, one containing the two species of *Chatrabus* plus *Pseudobatrichthys* and the other the remaining taxa. The former is defined by the same four putative synapomorphies in both analyses: # 6 (0→1), # 18 (0→1, CI = 1), # 31 (6→1), and # 45 (4→2). Both analyses list the same five autapomorphies for *Pseudobatrichthys* (# 21, 2→3, # 26, 2→1, # 27, 4→6, # 29, 1→0, and # 38 3→4), and four putative synapomorphies for the two species of *Chatrabus* (# 4, 0→1, # 33, 2→1, # 39, 2→3, and # 50, 0→1). *Chatrabus melanurus* has two autapomorphies (# 26, 2→3, and # 27, 4→7) and *C. hendersoni* one (# 21, 2→1). Within the remaining clade, *Colletteichthys* (# 15, 3→6, CI = 1, # 20, 2→1, and # 29, 1→0) is the sister group to the remaining six taxa (# 26, 2→3, # 47, 0→1, and # 50, 0→5) in both analyses. *Barchatus* (no autapomorphies) is the sister group to the last five taxa, which are united by a single, homoplastic character state (# 5, 0→1). *Riekertia* is defined by three homoplastic character states (# 21, 2/3→1, # 27, 3→1, and # 39, 2→3), and the remaining four taxa form a group also based on three putative but homoplastic synapomorphies: # 31 (6→1), # 33 (2→1), and # 49 (0→2). No further resolution of these four genera was present in either analysis.

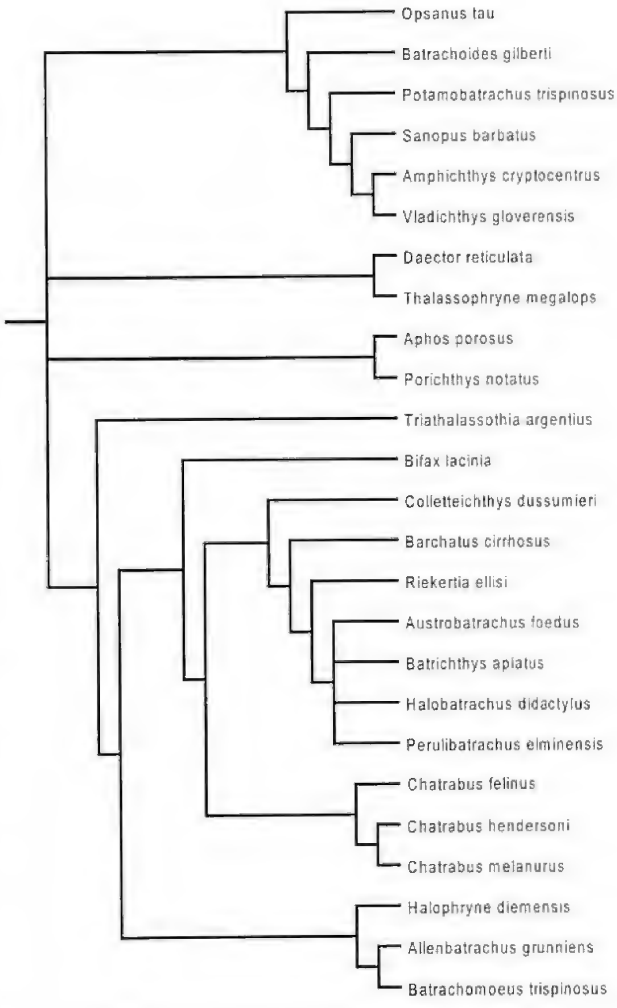

FIGURE 79. Visual consensus tree of figures 77 and 78.

DISCUSSION.— In addition to the two trees detailed above, eight other analyses were performed with the following outgroups or combinations of outgroups selected from the potential taxa mentioned under Phylogenetic Analytical Methods: *Draconetta*, *Ogilbia*, *Raniceps*, and *Synchiropus* (here abbreviated to the first letter of the taxon name): O only, R only, S only, D + R, D + S, D + S + R, O + R + S, and O + S. The trees vary considerably in resolution, from almost completely resolved (e.g. S as outgroup) to almost no resolution (e.g. D + R as outgroups). Figure 80 gives the R + S tree with the number of trees congruent with the node separated by a "/" from the total number of trees that were informative about that node. There are three contentious nodes. The New World (NW) taxa, with the exception of *Triathalassothia*, form a monophyletic clade in the R + S tree and in a total of five of the six analyses for which information about this node is present (Fig. 80). The only analysis which disagrees with this is the D tree, which places ((*Daector* + *Thalassophryne*) + (*Aphos* + *Por-ichthys*)) as the sister group to the Old World (OW) taxa. The second disagreement involves the sister group status of the two pairs of genera above, which is found in

two of the eight trees with information on this node. The R + S tree forms part of a group of six of the eight informative trees in which *Aphos* + *Porichthys* forms the sister group to the rest of the NW taxa (as defined above), and *Daector* + *Thalassophryne* forms the sister group to remaining six NW taxa. The final incongruence is in the tree generated using S as the only outgroup, which places *Triathalassothia* as the basal taxon of the NW taxa. While this results in congruence with other NW taxa, four of the other analyses have this genus in a basal tri- or poly-chotomy, and are thus uninformative; the other five all place it as the basal taxon to the rest of the OW taxa. *Triathalassothia* is located on the southeastern coast of South America, closer geographically to other OW taxa in Africa than any of the NW taxa.

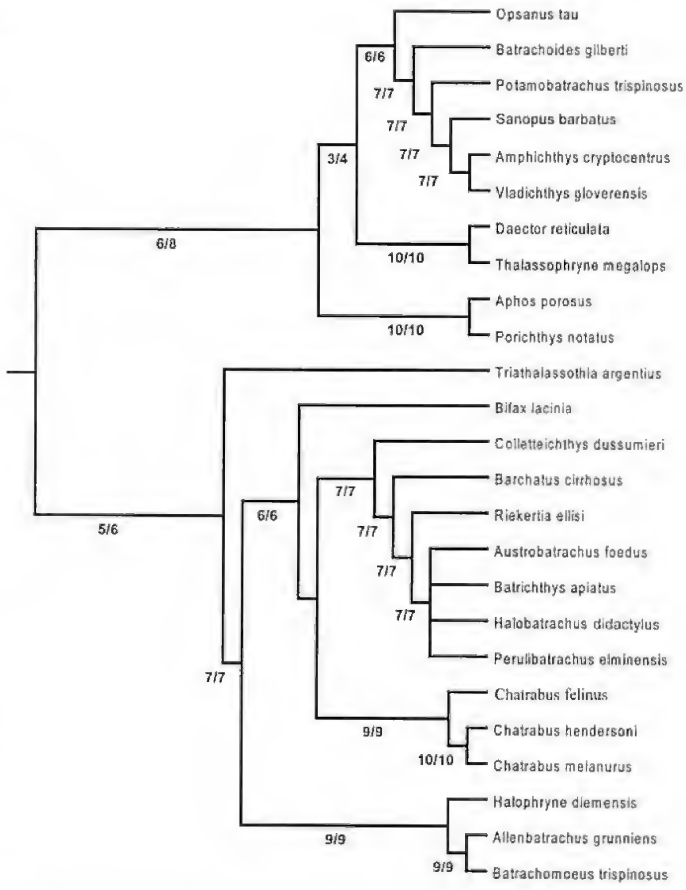

FIGURE 80. *Raniceps/Synchiropus* consensus tree with % congruence with other trees.

It must be stressed here that, despite the congruence of numerous trees based on different outgroups (or combinations thereof), most of the nodes are poorly supported by the available evidence (see Bremer Support indices in Figs. 77 and 78). This is especially true in the basal portions of the trees, and is further compromised by the fact that most of the supporting character states for these nodes exhibit a disturbing amount of homoplasy (occasionally as low as CI = 0.125). Despite this, the perfect congruence for those analyses yielding information for all the nodes except those discussed above is perhaps suggestive.

The only published phylogenetic reconstruction with information pertinent to toadfish intrarelationships is that of Smith and Wheeler (2006). They included representatives of six genera of toadfishes as part of a much broader study of acanthomorphs. Their results indicate that the OW taxa are paraphyletic with respect to a monophyletic NW group, and that this latter grouping exhibits a different structure from any of those developed in our analyses. The relationships they found can be expressed as (*Perulibatrachus* (*Allenbatrachus* (*Porichthys* (*Opsanus* (*Thalassophryne*, *Daector*))))). We do not explore this hypothesis further, other than to suggest that a possible reason for the discrepancy may be due to taxon sampling (6 vs. our 25), and to express some concerns regarding the validity of the implied alignments generated by the POY algorithm they used.

In summary, we believe our results as presented in Fig. 79 represent the best hypothesis of toadfish relationships available to date. We are also inclined to accept that (*Daector* + *Thalas-*

sophryne) and (*Aphos* + *Porichthys*) nest with the remaining NW taxa, although whether this is as a monophyletic sister group to them, or as sequential sister groups is unclear.

We remain uncertain as to the relationships of *Triathalassothia* because the basal batrachoid relationships are so weakly supported and because of its South American provenance. However, because five of the six informative trees place it basal to the OW taxa, with which it shares a number of character states not found in any of the NW taxa, we have placed it in that clade in our classification. We recommend the retention of the existing supra-specific taxonomy for the subfamilies Porichthyinae and Thalassophryninae, restricting the use of the Batrachoidinae to the six NW genera in the *Opsanus* – *Vladichthys* clade, erecting a new subfamily for the OW taxa (Halophryninae), and leaving *Triathalassothia* as *incertae sedis* until reliable information on its phylogenetic position becomes available.

Biogeographical Relationships

A key factor in the biogeography of any group of organisms is their ability to disperse from one geographic area to another, which in turn, is related to their mode of reproduction and dispersal. Toadfishes have demersal eggs that are laid in a nest that is guarded by the male. After hatching, unlike most other demersal spawners, the larvae do not move up into the water column to disperse, but rather stay attached to the substratum until most of the yolk sac has been absorbed, at a size of about 12 to 16 mm total length (Gill 1907; Collette 2005) (Fig. 81).

Figure 81. Larval *Thalassophryne maculosa*, Cubuga, Venezuela. Photograph courtesy of P. Humann.

This greatly reduced dispersal ability should increase the probability for genetic isolation between those individuals that manage to disperse some distance and form a founding population and those in the original population. The results of such potential isolation can be seen in some toadfish genera such as *Sanopus*, where the species have rather limited distributions. *Sanopus* has six species, all occurring in the tropical western Atlantic. *Sanopus reticulatus* is known only from Progresso on the northern coast of Yucatán, Mexico, *S. johnsoni* and *S. splendidus* are known only from Isla Cozumel off the east coast of Yucatán, Mexico, *S. greenfieldorum* and *S. astrifer* are both only known from Belize, but *S. greenfieldorum* is only known from the barrier reef, and *S. astrifer* only from the atolls about 10—20 kilometers farther off shore. *Sanopus barbatus* ranges from southern Belize south to Panama (Collette 2003). Adding to the limited distribution of species in this area, *Vladichthys gloverensis* is only known from the barrier reef and atolls of Belize and the adjacent Bay Islands of Honduras.

Species of *Opsanus* in the western Atlantic also show limited distributions; *Opsanus tau* ranges from the Gulf of Maine south to Florida; *O. pardus* occurs along part of the western coast of Florida in the Gulf of Mexico; *O. beta* is found from Florida through the Gulf of Mexico to Belize; *O. phobetron* ranges from the Bahamas to northern Cuba, and *O. dichrostomus* is found from the southwestern coast of Cuba to the Yucatán Peninsula and Belize. Avise et al. (1987) used mitochondrial DNA to evaluate the population-genetic structures of two *Opsanus* species, *O. tau* and *O. beta*. They found that, even within the relatively limited geographic distributions of these two species, significant mtDNA structure was present, with *O. tau* divided into northern and southern genetic forms, and *O. beta* into Florida and Mississippi-Louisiana populations. They further

stated that the divergence values in toadfishes were slightly greater than those found for restricted geographic assemblages of freshwater fish populations. As discussed earlier under genus *Opsanus*, the validity of a disjunct species of *Opsanus* in Brazil (*O. brasiliensis*) is doubtful.

The genus *Thalassophryne* along the Atlantic coast of South America demonstrates a series of species replacements going from north to south: *T. megalops*, *T. maculosa*, *T. nattereri*, *T. punctata*, and *T. montevidensis* (Collette 1966).

In the Pacific Ocean the species in the genus *Porichthys* show a pattern of species replacement from the north in Canada south to Ecuador with minimal overlap (Walker and Rosenblatt 1988), and several Atlantic species show limited distributions (Collette 2003). The genus *Aphos*, the sister genus of *Porichthys*, occurs from Peru to Chile, to the south of *Porichthys* species except for *P. margaritatus* with which it overlaps in northern Peru. The genus *Batrachoides* in the Pacific also shows a north-south replacement of species with *B. waltersi* from Mexico to Costa Rica; *B. walkeri* and *B. boulengeri* only from the Bay of Panama; and *B. pacifici* from Panama south to Peru (Collette and Russo 1981).

Similar restricted distributions are found in species of Old World genera. Hutchins (1976, Fig. 17) has shown replacement of the four species of *Batrachomoeus* around Australia. Hutchins (1976, Fig. 8), also showed *Halophryne queenslandiae* being restricted to the east coast of Australia, *H. ocellatus* to the west coast, and *H. diemensis* to the north coast. Greenfield (1998) documented the distribution of *H. diemensis* to extend from Indonesia south through New Guinea to Australia, but is replaced in Pulau Waigeo, Indonesia and the Philippine Islands by *H. hutchinsi*. In South Africa similar limited distributions have been described for many of the species.

Toadfishes are, however, able to disperse as demonstrated by the presence of *Porichthys margaritatus* at the Galápagos Islands, 972 km from Ecuador. Toadfishes do occur on other islands, but all of these have been connected to the mainland at one time or another. Kricher (2002) points out that during the rainy season the Guayas River of Ecuador, with its many islands of floating vegetation, could be carried by the Humboldt Current to the Galápagos. Whether this is a possible mechanism of transport that could be used by toadfishes is unknown. The depth of water between South America and the Galápagos Islands is 2000 m, so movement along the bottom is unlikely. *Porichthys* does, however, unlike other toadfishes, move up into the water column at night to feed on zooplankton, so movement across open water is possible, but unlikely, for species in this genus. In reviewing early stages of fishes found in the California Current region, Watson (1996:546) states "However, newly released juveniles, primarily *P. notatus*, occasionally are taken in CalCOFI samples." In discussing dispersal abilities of toadfishes, Walters and Robins (1961:20) reported "Robins observed several individuals of another batrachoidid (*Porichthys*) rafting on logs 25 miles from land in the Gulf of Panama during the summer of 1957..." They also stated "In addition, young *O. beta* often hide in sponges, which in stormy weather may be torn free from the bottom and float suspended in the water, pushed onward in advance of the storm."

The limited distributions of species from so many different toadfish genera and the population structure within *Opsanus* species, clearly demonstrates the increased potential for isolation resulting from their limited dispersal ability. In addition, two studies on the movement of *Opsanus tau* (Isaacson 1964; Schwartz 1974) found that the adults had restricted movements. These factors also explain the continental distribution of toadfishes, their having failed (with the exception of the Galápagos) to reach islands that were not at one time connected to a continental area or very close during previous sea level drops. What is seen at the species level should be kept in mind when considering biogeographical relationships of the genera.

Geographic Patterns

Probably the most unexpected result from the phylogenetic analysis was the emergence of two major clades, one composed wholly of New World genera (Batrachoidinae), and the other of Old World genera (Halophryninae) with the exception of *Triathalassothia*, with two species, that occurs on the southeastern coast of South America. One species of the New World genus *Batrachoides* occurs in the eastern Atlantic Ocean off Africa (*B. liberiensis*), but the other eight species are New World. The basal position of *Triathalassothia* to the Old World clade, or the New World clade, and its geographical position, being closest to South Africa, suggest a relationship between the two areas. Other such relationships between New and Old World taxa in the Western Atlantic have been discussed recently by Floeter et al. (2008).

The world-wide distribution of toadfishes, and the division of them into two separate clades, New World and Old World, suggest that toadfishes originated prior to the final closing of the Tethys seaway (about 20 mya, McKenzie 1991). *Halobatrachus didactylus*, a Recent species, is recorded under that name from the Miocene of Algeria (Carnevale 2004). Thus, it, or a member of that generic lineage, was present in the general area at that time. Because *Halobatrachus* is part of the terminal lineage of Old World toadfishes, toadfishes must have evolved before that time because there have been an absolute minimum of nine speciation events in toadfishes prior to this. An even earlier origin is suggested by the presence of *Allenbatrachus* in India and Madagascar, discussed below.

Old World (Halophryninae)

The clade containing three genera, *Halophryne*, *Allenbatrachus*, and *Batrachomoeus* occurs from Australia north through the Indo-Australia Archipelago to Thailand and the Philippines, with *Allenbatrachus* extending to India, with an isolated species at Madagascar. Both *Halophryne* and *Batrachomoeus* are restricted to Australia and the Archipelago, and no other toadfish genus occurs in this area. Considering the limited dispersal ability of toadfishes, the occurrence of *Allenbatrachus* in both India and Madagascar is particularly interesting. Both *Allenbatrachus grunniens*, found in India, and *A. meridionalis* in Madagascar, are species that occur in estuaries and enter fresh water. A similar distribution pattern occurs in cichlids, with species of the genus *Etroplus* in India and those of *Paretroplus* in Madagascar. In discussing the cichlid distribution, Sparks (2004:599) concludes that it is "congruent with prevailing paleogeographic hypotheses regarding the sequence of Gondwana fragmentation." India and Madagascar were close to each other until the Late Cretaceous, about 88 MYA (Hay et al. 1999). If in fact the distribution of *Allenbatrachus* is the result of this vicariance scenario, then this suggests this clade had evolved by that time.

The "Gondwana clade" is sister to a large clade of 10 genera all found off Africa or in the northwestern Indian Ocean. Basal to this clade is *Bifax lacinia*, a distinctive, brightly colored species with maxillary flaps with eye spots, found only in the Arabian Sea. *Bifax* is sister to a clade with two subdivisions, one with only *Chatrabus*, found in south and western Africa. The other subdivision contains seven genera. Basal to that latter clade is *Colletteichthys dussumieri*, a species ranging from the Arabian Sea to India and Sri Lanka. The next two genera branching off that clade are *Barchatus* and *Riekertia*, each monotypic. *Barchatus cirrhosus* occurs only in the Red Sea, being geographically adjacent to *Colletteichthys dussumieri*, and *Riekertia ellisi* is known only from Durban to Port St. Johns (Transkei), South Africa. Although there are osteological differences between *Barchatus* and *Riekertia*, externally they are very similar.

Santini and Winterbottom (2002) hypothesized that the Arabian and Red Seas together is the

sister area of the whole rest of the Indo-West Pacific. The ancestor of the *Bifax* → *Chatrabus* clade inhabited this area, as well as the ancestor of the *Colletteichthys* → *Perulibatrachus* clade, suggesting a potential vicariant event congruent with their hypothesis.

Riekertia is the sister to an unresolved clade with four genera, *Austrobatrachus*, *Batrichthys*, *Halobatrachus*, and *Perulibatrachus*. Although unresolved phylogenetically, only *Halobatrachus* and *Perulibatrachus* occur on the west coast of Africa. Based on the close correlation between phylogenetic relationships and geography in other genera, this would suggest that *Halobatrachus* and *Perulibatrachus* might be sister taxa. *Halobatrachus didactylus* ranges from Straits of Gibraltar south to Nigeria with a fossil in Algeria. *Perulibatrachus elminensis* ranges from Ghana to Walvis Bay, Namibia, and *P. rossignoli* ranges from Gabon south to Walvis Bay, Namibia. *Halobatrachus didactylus* only overlaps slightly with *P. elminensis* in geographic distribution (Collette and Greenfield in press; Collette et al. 2006).

Besides occurring on the western coast of Africa (*P. elminensis* and *P. rossignoli*), the genus *Perulibatrachus* also occurs in Natal, southeastern South Africa and India (Greenfield 1996, 2005). *Perulibatrachus kilburni* is known only from Natal, and *P. aquilonarius* only from Madras, India. Whether the presence of these species in Africa close to Madagascar and in India is another possible example of Gondwana influence is not known.

Austrobatrachus and *Batrichthys* are both known only from South Africa. *Austrobatrachus* is monotypic, *A. foedus*, and is known only from Algoa Bay to Coffee Bay, Transkei, South Africa. *Batrichthys* has two species, *B. apiatus* and *B. albofasciatus*, both found in the Transkei area. Thus, the two genera are in close proximity and may overlap.

New World (Batrachoidinae)

Isthmus of Panama

The rise of the Isthmus of Panama, about 3.1–3.5 Ma (Coates and Obando 1996), had a significant impact on toadfish evolution. The sister genera, *Daector* and *Thalassophryne* clearly were separated by this barrier. *Daector* is represented by four species all found in the tropical eastern Pacific, whereas *Thalassophryne* has six species all in the tropical western Atlantic Ocean (with one in fresh water draining into the Atlantic). Different species of *Porichthys* and *Batrachoides* are found on both sides of the Isthmus: *Porichthys* has eight species in the Pacific and five in the Atlantic, and *Batrachoides* has four species in the Pacific and five in the Atlantic. Because there are no toadfishes in the south Pacific, and toadfishes have limited dispersal abilities, the species along the Pacific coast of the New World were derived from the Atlantic Ocean.

Western Atlantic

The genus *Opsanus* is basal to the rest of the Batrachoidinae in the New World, and has a distribution that is more northern than the rest of the genera, occurring from the Gulf of Maine to Belize, except for the questionable species described from Brazil (*O. brasiliensis*). Walters and Robins (1961:19), citing Breder (1941), suggested that "It is evidently the spawning threshold of 19°–20°C that limits the distribution of *Opsanus tau* and its relatives both in the north and the south."

The genus *Batrachoides* is the sister to the rest of the Western Atlantic batrachoidin genera, with the exception of *Opsanus*. It differs from all other Western Atlantic genera in having scales, a character apparently independently derived from other genera with scales in the Old World. The major distribution of this genus is south of that of *Opsanus*. *Batrachoides gilberti* is the northern-

most species in the genus, occurring from the southern border of the Yucatán Peninsula with Belize south to Panama. Although occurring in Belize, this is a species that is restricted to the mainland, often entering fresh water, and not reaching the barrier reef or atolls where *Sanopus* and *Vladichthys* occur (Greenfield and Thomerson 1997). Other *Batrachoides* species extend south to Brazil.

The monotypic *Potamobatrachus* is the sister group to the remaining three genera. *Potamobatrachus trispinosus* is known only from the Río Tocantins, Para, Brazil. Its geographic position in northern Brazil, places it in an area where *Batrachoides* occurs.

The genus *Sanopus* is basal to *Amphichthys* and *Vladichthys*. *Sanopus* species range from the Yucatán, Mexico south to Panama, a distribution that is north of *Amphichthys* and adjacent to *Vladichthys*. *Sanopus* and *Vladichthys* species co-occur on both the barrier reef and atolls of Belize.

Amphichthys and *Vladichthys* are sister genera that are separated geographically. *Amphichthys cryptocentrus* ranges from Panama to Brazil, whereas *Vladichthys gloverensis* occurs only at the barrier reef and atolls of Belize and the Bay Islands of Honduras. *Vladichthys gloverensis* is a specialized, miniature species that because of its small size is able to live in coral-reef habitats not utilized by other toadfishes. Most other toadfishes are found on sand or mud bottoms, often burrowing under rocks or coral heads. It thus is possible that *Vladichthys* was derived from the more generalized *Amphichthys*, or they both evolved from the same ancestor.

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Appendix I

Material Examined

Cleared and Stained Specimens.— *Allenbatrachus grunniens*, CAS-SU 26909; *Allenbatrachus meridionalis* MNHN A-3777 (1); *Allenbatrachus reticulatus*, CAS-SU 30658; *Amphichthys cryptocentrus*, USNM 144888; *Aphos porosus*, CAS 65051; *Austrobatrachus foedus*, SAIAB 12748; *Barchatus cirrhosus*, HUJ 13711; *Batrachoides gilberti*, FMNH 84549; *Batrachomoeus trispinosus*, CAS 69938; *Batrichthys apiatus*, SAIAB 75-25; *Bifax lacinia*, BPBM 35843; *Chatrabus hendersoni*, SAIAB 8611; *Chatrabus felinus*, SAIAB 75-25; *Chatrabus melanurus*, SAIAB 12749; *Collettteichthys dussumieri*, USNM 147914; *Daector reticulata*, GCRL 16194; *Halobatrachus didactylus*, USNM 205066; *Halophryne diemensis*, NTMS 10005-019; *Halophryne hutchinsi*, CAS-SU 204-62; *Opsanus tau*, CAS 223821; *Perulibatrachus elminensis*, MNHN 1970-43; *Potamobatrachus trispinosus*, USNM 330064; *Porichthys notatus*, CAS 223822; *Riekertia ellisi*, SAIAB 12738; *Sanopus barbatus*, SIO 6745, MCZ 44549 (1); *Thalassophryne maculosa*, USNM 199524; *Thalassophryne megalops*, FMNH 66907; *Triathalassothia argentinus*, USNM 214438; *Vladichthys gloverensis* FMNH 91036.

Non-batrachoid specimens cleared and stained: *Draconetta oregoni* CAS168909 (1); *Synchiropus atrilabiatus*, CAS 168910 (5); *Foetorepus agassizi* USNM 188524 (1); *Raniceps raninus* CAS 225749 (1), USNM 35222 (1- parts only C & S); *Lophius americanus* MCZ 51259 (1); *Merluccius productus* CAS225753 (3), CAS 225754 (4); *Antennarius coccineus* CAS 225751 (1); *Gobiesox maeandricus* CAS 225752 (1); *Brachionichthys hirsutus* CAS 225750 (1); *Ogilbia robertsoni* CAS 81418 (1). .

Other Specimens.— *Allenbatrachus grunniens* CAS 75217 (2), CAS 75218 (1), CAS-SU 32944 (2), CAS-SU 27732 (4), CAS-SU 38261 (1), CAS-SU 38262 (1), CAS-SU 41321 (1), ANSP 48743 (1), ANSP 77373 (1), AMS B.8319 (1), USNM 047986 (1), USNM 148493 (1); *Allenbatrachus meridionalis* AMNH 233686 (holotype), AMNH 234024 (1), CAS 220508 (1), MNHN 1992-0670 (1), MNHN 1962-0197 (3) *Allenbatrachus reticulatus* CAS-SU 33701 (1), CAS-SU 35153 (2), CAS 82188 (neotype), CAS 66821 (1), CAS 75216 (1), CAS 17652 (1), CAS 88690 (7), CAS 225745 (3), CAS 225746 (4), AMS I.21036003 (2), USNM 333283 (5); *Amphichthys cryptocentrus* CAS-SU 52346 (2), CAS-SU 52347 (1),CAS 225744 (3), USNM 144888 (1); *Austrobatrachus foedus* RUSI 12744 (1); *Barchatus cirrhosus* USNM 221140(1); BPBM 18303 (1), TAU P-12259 (1- photographs only); *Batrachoides boulengeri* CAS-SU 6487 (holotype), CAS-SU 12815-6 (2), MCZ 12805 (1), USNM 80990-1 (3), USNM 220127 (4), LACM W58-304-1 (3); *Batrachoides gilberti* USNM 81002 (holotype), USNM 81002 (1), USNM 81003 (5), FMNH 71317 (1), FMNH 86588 (1), FMNH 84549 (14), ANSP 123884 (1), AMNH 35033 (1); *Batrachoides goldmani* USNM 50006 (holotype), USNM 219383 (4),UMMZ 144152 (1), UMMZ 144156 (6), AMNH 25623 (1), AMNH 24532 (1); *Batrachoides liberiensis* NHMV 5558 (holotype), USNM 205067 (1), USNM 193648 (2), USNM 219393 (5), ANSP 140358 (1), FMNH 83861 (1); *Batrachoides manglae* ANSP 102200 (5), USNM 218893 (1); *Batrachoides pacifici* BMNH 1860.6.18.11 (lectotype), MCZ 12755-57 (6), USNM 80999 (2), USNM 53486 (4), USNM 144882-3 (4), FMNH 26090-95 (6), SIO 70-366 (3), LACM 32732-1 (1), CAS-IU 15050 (2), CAS-SU 6872 (14) ; *Batrachoides surinamensis* USNM 44463 (1),USNM 9368 (1), USNM 159249 (3), USNM 219462 (3), FMNH 84547 (1), FMNH 84548 (1), ANSP 37901 (1), AMNH 9319 (2), MCZ 30164 (1), MCZ 12773 (4); *Batrachoides walkeri* USNM 220128 (holotype); *Batrachoides waltersi* LACM 33806-64 (holotype), CAS-SU 57002 (1), USNM 219788 (3), USNM 219789 (2), FMNH 91905 (3), SIO 73-257 (19); *Batrachomoeus trispinosus* CAS 35620 (4), CAS 27537 (1), CAS 35620 (4), CAS 66820 (1), CAS 27436 (1), CAS 74966 (1), CAS 81633 (1), CAS 74965 (3), USNM 72724 (1), USNM 150909 (1), AMS I.28978007 (1); *Batrichthys albofasciatus* RUSI 29413 (1); *Batrichthys apiatus* SAIAB 12728 (7), SAIAB 2348 (1), SAIAB 2345 (1), SAIAB 2346 (1), SAIAB 12731 (3), SAIAB 12733 (15); *Bifax lacinia* BPBM 35949 (holotype), BMNH 1994.4.5.1 (1), BPBM 36210 (1), BPBM 35731 (1), CAS 81232 (1), USNM 329111 (1); *Chatrabus felinus* SAIAB 4341 (1), SAIAB 75-23 (1); *Colletteichthys dussumieri*, USNM 147914 (3), USNM 047986 (1), USNM 333284 (3), USNM 333281 (1), USNM 196473 (1), USNM 221342 (5), USNM 226512 (1), USNM 147913 (7), USNM 147915, CAS 23719 (1), CAS 29743 (1), BPBM 30509 (1), BPBM 29525, AMS B.8115 (1), AMS B.8112; *Daector dowi* USNM 128235 (holotype), USNM 39085 (1), USNM 41232 (2), USNM 188844 (11), CAS 58304 (14), SIO 64-386 (4), FMNH 62736 (2); *Daector gerringi* NRS 10651 (holo-

type); *Daector quadrizonatus* USNM 206335 (1); *Daector reticulata* BMNH 1864.1.26.342 (holotype), CAS-SU 14949 (1), CAS-SU 22287 (4), USNM 81698 (2), USNM 81699 (1),USNM 81700 (2), MCZ 41806 (3), ANSP 70346 (1); *Daector schmitti* USNM 144869 (holotype), CAS-SU 14949 (paratypes); *Halobatrachus didactylus* MCZ224-5 (2), MCZ 12787 (1), USNM 205060 (1), USNM 205062 (1), USNM 205063 (1), USNM 205064 (1), USNM 205065 (1), USNM 205066 (1),UMML 16893 (2), UMML 16854 (4); *Halophyrne diemensis* FMNH 23284 (1), USNM 221343 (1), USNM 174024 (1), AMS I.1564k002 (1), AMS I.18553001 (2), AMS S-10600-020 (2), NTMS 10600-020 (2); *Halophyrne hutchinsi* USNM 150899 (holotype), USNM 150927 (1), USNM 219797 (1), FMNH 47500 (1), FMNH 52489 (1), CAS-SU 38260 (1), CAS 126908 (11); *Halophyrne ocellatus* AMS I.7029 (1), WAM P25058-001 (1); *Halophyrne queenslandiae* CAS 120529 (1), AMS I.9500 (1); *Opsanus beta* USNM 21477 (1), USNM 23541 (1), UMMZ 184510 (2), ANSP 68629 (1); *Opsanus dichrostomus* USNM 361063 (holotype), USNM 361064 (3 paratypes), CAS 225748 (1) FMNH 110990 (1), FMNH 110991 (1), FMNH 110992 (2), UMMZ 102169 (1), UMMZ 184702 (1), UF 13365 (1); *Opsanus pardus* USNM 22217 (2), USNM 73173 (1), USNM 301941 (1), UF 204220 (1); *Opsanus phobetron*, USNM 170961 (paratype) USNM 170962 (1), ANSP 79480 (paratype), ANSP 79481 (paratypes), UF 2027128 (1), MCZ 34708 (1); *Opsanus tau* USNM 48976 (1), USNM 45460 (1), USNM 91202 (2), USNM 301995 (1); *Perulibatrachus aquilonarius* CAS-SU 41322 (holotype); *Perulibatrachus elminensis* MNHN 1967-909 (1); *Perulibatrachus kilburni* SAIAB 28203 (holotype); *Perulibatrachus rossignoli* CAS 223402 (1); *Potamobatrachus trispinosus* MZUSP 4335 (holotype), MNHG 2575.53 (1); *Riekertia ellisi* SAIAB 12739 (1), SAIAB 12742 (1); *Sanopus astrifer* USNM 259421-F1 (holotype), UMML 9415 (paratypes), ANSP 102736 (3-paratypes), FMNH 71318 (1), USNM 209720 (1); *Sanopus barbatus* FMNH 91031 (1), CAS 225747 (1), USNM 81009 (1), USNM 22522 (1), MCZ 44550 (1); *Sanopus greenfieldorum* USNM 213555 (holotype), USNM 261601 (paratypes), FMNH 94517 (paratypes); *Sanopus johnsoni* USNM 205945 (holotype); *Sanopus splendidus* USNM 205944 (holotype), ANSP 117316 (paratypes), UMML 29141 (paratypes), USNM 205606 (paratypes), USNM 205607 (paratypes), CAS 29110 (paratypes); *Thalassophryne amazonica* USNM 200560 (1), USNM 200559 (3); *Thalassophryne megalops* USNM 37669 (holotype), USNM 197643 (paratypes), USNM 200556 (2), FMNH 66832 (1), ANSP 103620 (2); *Thalassophryne montevidensis* MNH 37 (holotype), MACN 5267 (1), USNM 200350 (3); *Thalassophryne nattereri* MCZ 12726 (lectotype), BMNH 1924.7 (2), MNHN 03-40 (1), MNHN 04-19 (1), USNM 187975 (1), USNM 200555 (1), FMNH 66273 (1), FMNH 66275 (1), CAS-SU 2223 (holotype of *T. branneri*); *Thalassophryne punctata* MCZ 4632 (lectotype); *Triathalassothia argentinus*, USNM 86687 (1), USNM 214438 (1), ANSP 70373 (1); *Vladichthys gloverensis*, FMNH 71575 (holotype), Paratypes- FMNH 71576 (1), FMNH 71577 (2), FMNH 71578 (2), FMNH 71579 (1), FMNH 71580 (1), FMNH 91036 (1), USNM 318691 (1), USNM 208239 (3), ANSP 120499 (5), CAS 15409 (3), BMNH 197.10.10.97 (1)

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A New Species of Indo-Pacific Moray Eel (Anguilliformes: Muraenidae) From Indonesia

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Gymnothorax davidsmithi **species novum, subfamily Muraeninae, is described from a specimen collected in 3-4 m from Flores, Indonesia. It is distinguished from its congeners by having 4-64-156 vertebrae, mostly uniserial dentition, and by its coloration of a tan body and tail overlain in the head region by numerous white spots and markings.**

KEYWORDS: Muraenidae, *Gymnothorax* new species, Indonesia

While diving in shallow water in Flores, Indonesia, the junior author collected a number of new marine fish species that had not been seen in similar habitats in a variety of better-sampled Indo-Pacific locations. This location and its habitat are apparently quite different than similar shallow water habitats and it is likely that more intensive collective in this area will uncover additional unknown species. This new species of moray eel is known from a single individual; however, it is distinctive enough in many characteristics that we herein describe it and take particular pleasure in doing so by naming it after our friend and colleague David G. Smith.

Materials and Methods

Measurements are straight-line, made with a 300 mm ruler with 0.5 mm gradations (for total length, trunk length, and tail length), and recorded to the nearest 0.5 mm, or with dial calipers or dividers for all other measurements and recorded to the nearest 0.1 mm. Proportions are expressed in terms of total length (TL), measured from the snout tip to the end of the tail, or head length (HL). Body length is head plus trunk length. Head length is measured from the snout tip to the posterodorsal margin of the gill opening; trunk length is taken from the end of the head to mid-anus; body depth is measured at the gill opening and at the anus and does not include the fins; body width is measured immediately behind the gill openings and above the anus; snout length is measured from the snout tip to the anterior margin of the eye; upper-jaw length is measured from the snout tip to the external inner angle of the mouth. Head pore terminology follows that of Böhlke et al. (1989). Vertebral counts (which include the hypural) were obtained from radiographs as described by Böhlke (1982); the mean vertebral formula (MVF) is expressed as the mean value for predorsal/preanal/total counts. Tooth counts are approximate and include sockets of missing teeth. Institutional abbreviations follow Leviton et al. (1985).

Taxonomy

***Gymnothorax davidsmithi* McCosker and Randall, sp. nov.** Smith's moray
Figures 1-3.

Material Examined.— Holotype: BPBM 34099, 299 mm TL, sex undetermined; Indonesia, Flores, east of Maumere Bay, inshore of wreck of Japanese warship; collected using rotenone in 3-4 m over dark silty sand with some *Halophyla* by J.E. Randall and R.M. Pyle on 17 September 1988.

Diagnosis.— An elongate, slender brown moray with white spots on head and anterior throat region; anal fin with a pale margin; anus before midbody, preanal length 2.15 in TL; depth at gill opening 33 in TL; head 10.7 in TL; middle of orbit above middle of jaw; jaws moderate, not recurved; teeth conical, mostly uniserial, jaw teeth numerous and closely spaced; coloration uniform tan overlain with white spots and markings on throat, forehead, cheeks, nape and anterior branchial basket; MVF 4-64-156.

Measurements (in mm) and counts of the holotype.— Total length 299; head length 27.9; preanal length 139; snout to dorsal-fin origin 21.2; depth at gill opening ~9.0; depth at anus ~8.0; width at gill opening ~5.7; width at anus ~5.0; length upper jaw 10.0; length lower jaw 9.9; snout length 4.9; eye diameter 3.0; fleshy interorbital width 3.0; gill-opening length 1.2. Predorsal vertebrae 4, preanal vertebrae 64, total vertebrae 156.

Description.— An elongate (Fig. 1) slender moray, depth at gill opening 33, depth at anus 37 in TL; anus before midbody, preanal length 2.15 in TL. Head moderate, 10.7 in TL; snout 5.7 in HL; jaws moderately elongate, closing completely; lower jaw slightly inferior; upper jaw 2.8 in HL. Eye moderate in size, its diameter 9 in HL, its center above middle of jaw. Interorbital space as wide as orbit. Anterior nostril in a short, anteriorly directed tube, nearly reaching tip of snout; posterior nostril a round opening above and within anterior quarter of eye, its margin smooth. Dorsal-fin origin above and anterior to first branchial pore, equidistant between gill opening and rictus. Skin above origin of dorsal fin flabby, loose. Dorsal fin slightly elevated in anterior half of body. Gill opening a small slit below midside. Predorsal vertebrae 4, preanal vertebrae 64, total vertebrae 156.

Figure 1. Holotype of *Gymnothorax davidsmithi* sp. nov., BPBM 34099, 299 mm TL. Photographed by J.E. Randall soon after its capture.

Head pores (Fig. 2) typical of *Gymnothorax* but reduced in number, most are discernable; supraorbital 1+2; infraorbital 4; mandibular 5; 2 minute branchial pores above and anterior to gill opening.

Teeth (Fig. 3) conical, recurved. Jaw teeth mostly uniserial. An anterior rosette of 5 evenly spaced teeth at snout tip, followed by 3 large fangs, flanked by 2 premaxillary teeth, a gap,

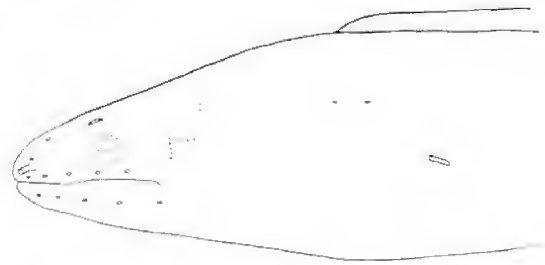

Figure 2. Head of holotype of *Gymnothorax davidsmithi* sp. nov., BPBM 34099, 299 mm TL.

and 7 small uniserial vomerine teeth. Maxillary teeth uniserial, with 2 longer teeth medial to a linear row of 15 (left) and 16 (right) smaller, closely set teeth. Mandible with 4 largest teeth along each side of gap, followed by 16-17 strictly uniserial smaller closely spaced teeth.

Body coloration in (ethyl alcohol) (Fig. 1) tan to brown, slightly darker dorsally, overlain on throat, forehead, cheeks, nape, and anterior branchial basket with an irregular patchwork of white spots and markings, becoming uniform tan from mid-throat to tail-tip. Suborbital and mandibular pores within large white spots. Anterior nostrils pale laterally, slightly pigmented medially. Anal opening pale. Anal fin brown, its margin pale. Dorsal fin brown like body. Inside of mouth and peritoneum have a fine brown speckling.

Size.— Known only from the holotype, 299 mm TL.

Etymology.— We are pleased to name this in honor of David G. Smith, in recognition of his contributions to the understanding of anguilliform fishes.

Distribution.— Known only from east of Maumere Bay, Flores, Indonesia, 3-4 m depth.

Remarks.— As currently recognized, *Gymnothorax* comprises more than 100 species and is by far the most speciose of muraenid genera. Several subgenera are recognized (Böhlke et al. 1989); however, the new species cannot easily be placed within any of them. It differs from all known *Gymnothorax* in a combination of characters including its having 4-64-156 vertebrae and mostly uniserial dentition, and in its coloration of a tan body and tail overlain in the head region by numerous white spots and markings.

Vertebral numbers and location relative to the dorsal-fin origin and anal-fin origin are reliable characters for species identification. Using the comprehensive catalogues of Böhlke and Smith (2002), Smith and Böhlke (2006), and Böhlke et al. (1989), the new species is similar to (but does not overlap with) the vertebral formulae of: the deepwater Atlantic species *G. madaerensis* (Johnson, 1862) (MVF 6-68-153), the southwestern Pacific species *G. intesi* (Fourmanoir and Rivaton, 1979) (MVF 5-68-155), and the western Atlantic species *G. kolpos* Böhlke and Böhlke (1980) (MVF 6-63-164). It differs from all of the above-mentioned species in its coloration and dentition.

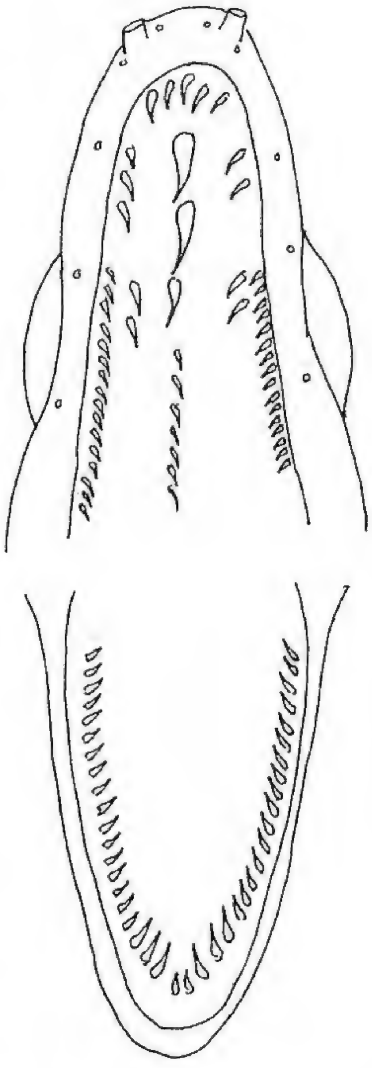

FIGURE 3. Semidiagrammatic illustration of dentition of holotype of *Gymnothorax davidsmithi* sp. nov., BPBM 34099, 299 mm TL.

The new species is similar in general coloration and dentition to the Australian species *G. cephalospilus* Böhlke and McCosker (2001); however, it has more vertebrae (4-64-156 vs. 6-64-145) and the spotting of *G. cephalospilus* extends well beyond the head region. It is also similar in appearance to the western Indian Ocean species *G. punctatus* Bloch and Schneider (1801), but it has more vertebrae (4-64-156 vs. 5-54-134) and the spotting of *G. punctatus* continues onto its body and tail.

Acknowledgments

We wish to thank the staffs of the Bernice P. Bishop Museum (BPBM) and the California Academy of Sciences (CAS) for advice and assistance with specimens and David Greenfield for reading a draft of this manuscript.

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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES

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Notes on *Brachysomophis atlanticus* from the Cape Verde Archipelago

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Living snake eels of the rare species *Brachysomophis atlanticus* Blache and Saldanha were observed and photographed by scuba divers in 8–10 m off Santiago Island, Cape Verde Archipelagop. Their behavior and life coloration are described for the first time. Comparisons of behavior and anatomy are made with its congeners.

The snake eel *Brachysomophis atlanticus* was described by Blache and Saldanha (1972) on the basis of two specimens (263–273 mm TL) from Sénégal and from Principe Island, Gulf of Guinea. They knew little about the provenance of their specimens and listed the data and depth of their captures as "non précisées". Bauchot et al. (1993:104) stated that the holotype was from a fish's stomach. McCosker and Randall (2001:7–8) re-examined the type specimens and reported upon an additional specimen (~170 mm TL) from Príncipe that had been decapitated by a dredge at 75 m depth. Nothing concerning this species has subsequently appeared.

In 2007, the junior author observed several living *Brachysomophis atlanticus* while diving at night off King Bay (15°16'31"N, 23°45'45"W), Tarrafal, Santiago Island, Cape Verde Archipelago. The eels were burrowed in the sand at 8-10 m depth with only their heads exposed. Photographs were taken and a specimen was captured in July 2008. We herein report upon that specimen, provide data concerning its coloration, meristics and morphometrics, and comment upon observations made of its *in situ* biology. The specimen is a female with developing oocytes and contained a 4 cm TL sharpnose puffer *Canthigaster capistrata* in its stomach. A sample of the eel's liver was preserved in 96% EtOH and is deposited, along with the specimen (CAS 227135), in the ichthyological research collection of the California Academy of Sciences. The specimen has the following measurements (in mm) and meristics: total length (TL) 380; head 46.8; trunk 145; tail 188; dorsal-fin origin 43.1; snout 4.5; upper jaw 16.2; eye 2.4; interorbital 3.5; pectoral-fin length 7.4; pectoral-fin base 3.1; gill opening 6.5; isthmus 4.1; depth at gill openings ~13.5; width at gill opening 12.4; vertebrae 7/52/116. The proportions of the Cabo Verde specimen are very similar to those of the

FIGURE 1. Living *Brachysomophis atlanticus* (CAS 227135), 380 mm TL, photographed by P. Wirtz soon after capture off Tarrafal.

smaller type specimens. The cephalic pores and dentition are nearly identical to those illustrated in Blache and Saldanha (1972: figs. 12–13). Its vertebral count allows the first documentation of the predorsal and preanal counts for this species, and that, along with the total vertebral counts of the holotype (114) and paratype (117), establishes its mean vertebral formula as 7/52/115.7. The coloration of the fresh specimen (Fig. 1) deserves comment: the body and tail of the living specimen is colored much like that of those in preservative (white ventrally, becoming yellowish above the lateral midline, overlain with 22 large, rounded, saddle-like brown spots, many of which meet across the dorsal midline and extend beneath the level of the lateral line). The four white spots along the mandible are prominent. The head of the specimens observed *in situ* is variable in coloration, not unlike that of *B. henshawi* (*cf.* McCosker and Randall 2001: Plate II D–G). The background coloration of the head of the Cape Verde specimen is much like that of the body; however its nape and chin are overlain with a reddish-brown patch. Another individual, photographed but not collected (Fig. 2), appeared to be the size of the collected specimen and its nape and chin were dark pink with a smattering of darker pink patches on its snout and cheeks. Another eel (Fig. 3), photographed but not collected, was approximately twice the length of the collected specimen and similar in its brown and white head coloration.

FIGURE 2. *Brachysomophis atlanticus* photographed at night by P. Wirtz at 8 m depth off Tarrafal.

FIGURE 3. *Brachysomophis atlanticus*, a larger individual than those in Figures 1-2, photographed at night by P. Wirtz at 8 m depth off Tarrafal.

All eels observed (two individuals in 2007, probably five individuals in 2008) were seen on a sandy, near horizontal area in 8-10 m depth in King Bay, less than 30 m from the shoreline and perhaps 200 m in extent. No individuals of this species were seen on another, larger sandy area in the same bay in 20 m depth, despite a careful search for them. The junior author has only seen this species during eight night dives in that area; however, one of the local dive guides stated that he has also seen at least one during daytime. The closest distance observed between individuals was about 5 m. Individuals observed in consecutive night dives on following days were not seen at precisely the same location, but this may have been the result of disturbance by the photographer.

A careful examination of the *Brachysomophis atlanticus* specimen has allowed us to compare it to its congeners. We find that it is similar to *B. henshawi*, a wide-ranging Indo-Pacific species known from Hawaii to Oman (McCosker and Randall 2001). They are nearly identical in the shape of their head such that the flesh above and behind the eyes is laterally elevated as a ridge and the dorsal head profile is notably depressed and constricted behind the eyes (see McCosker and Randall 2001: fig. 6), forming a lateral cave behind the dorsal margin of the eye. Although present in other *Brachysomophis*, the development of that cave is most prominent in *B. atlanticus* and *B. henshawi*. They are also very similar in the shape of their pectoral fins (short and rounded rather than

elongate, as in other species of *Brachysomophis*). They differ in their body colorations (large spots vs. minute spots, and a pale dorsal-fin base vs. a dark base), their dorsal-fin origins (above gill opening vs. behind pectoral fin tips), the condition of their labial cirri (numerous and slender vs. fewer and stout), in their dentition (the teeth of the inner maxillary row of *B. atlanticus* are considerably more elongate), and in their vertebral numbers (114–117 vs. 128–134).

Acknowledgments

We thank the staffs of the California Academy of Sciences (CAS), San Francisco, and the Muséum National d'Histoire Naturelle (MNHN), Paris for assistance with data and specimens. The junior author wishes to thank the staff of the King Bay diving center, Emanuel d'Oliveira and Georg Bachschmid, for their help and friendship. The Centro de Ciências do Mar (CCMAR) of the University of the Algarve, Portugal, partly financed both trips of the junior author. Mysi Hoang (CAS) assisted with Figure 1. Laurie Kormos (CAS) assisted with radiographs. Tomio Iwamoto (CAS) kindly reviewed a draft of this manuscript.

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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES

Series 4, Volume 59, No. 18, pp. 719–722, 15 figs. December 30, 2008

A Revision of the Malagasy Ants Belonging to the Genus *Monomorium* Mayr, 1855 (Hymenoptera: Formicidae) Amendment

Brian Heterick[1]

Department of Entomology, California Academy of Sciences, 55 Music Concourse Drive, San Francisco CA 94118

The author has been alerted to the presence of several errors in the following publication that require correction:

Brian Heterick. 2007. A Revision of the Malagasy ants Belonging to the Genus *Monomorium* Mayr, 1855 (Hymenoptera: Formicidae). *Proceedings of the California Academy of Sciences*, ser. 4, 57(3): 69-202.

The following corrections apply:

Keys (original p. 84–88): The published key to the *Monomorium* ant species contains a small error that may confuse users of the key. The word '**basal**' needs to be inserted in the first lug of couplet 27 (shown below in italics) in place of the word '**apical**'. The corrected lug will read:

'27. PF 3,2; four mandibular teeth, *basal* tooth twice as large as t3, sharp and downcurved (depigmented, pale yellow species) (Fig. 77). . . . . *M. ferodens* Heterick sp. nov.

Maps (original pp. 188–191): Ten of the distribution maps (namely, Figs 21–24, 26–27, 29–30, 32, and 34) included in the monograph were incorrectly reproduced. As published, they duplicate the data given in Figure 20. These maps appeared on pages188–191 and those pages are reproduced here (now numbered 720–722) with the corrected figures and their captions. Original figure F. 20 is repeated here for the purpose of comparison; Figures 25, 28, 31, and 32 are also originals.

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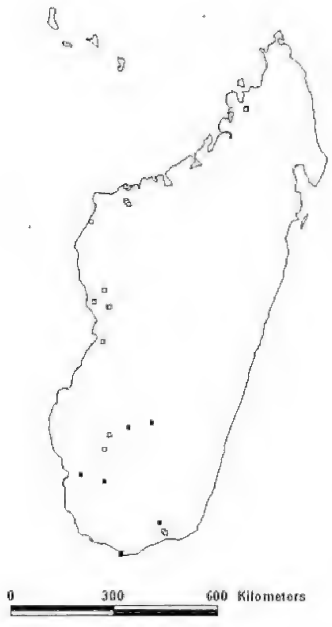

FIGURE 20. Distribution of *M.nigricans* (■) and *M. lepidum* (□) specimens examined during this study.

FIGURE 21. Distribution of *M. madecassum* (■) specimens examined during this study.

FIGURE 22. Distribution of *M. micrommaton* (□) and *M. platynodis* (■) specimens examined during this study.

FIGURE 23. Distribution of *M. sakalavum* (■) specimens examined during this study.

FIGURE 24. Distribution of *M. termitobium* (■) specimens examined during this study.

FIGURE 25. Distribution of *M. versicolor* (□) and *M. xuthosoma* (■) specimens examined during this study.

FIGURE 26. Distribution of *M. hanneli* (■) specimens examined during this study.

FIGURE 27. Distribution of *M. adiastolon* (□), *M. ferodens* (●), and *M. gongromos* (▲) specimens examined during this study.

FIGURE 28. Distribution of *M. aureorugosum* (□) and *M. infuscum* (■) specimens examined during this study.

FIGURE 29. Distribution of *M. cryptobium* (■) specimens ex-amined during this study.

FIGURE 30. Distribution of *M. fisheri* (■) specimens examined during this study.

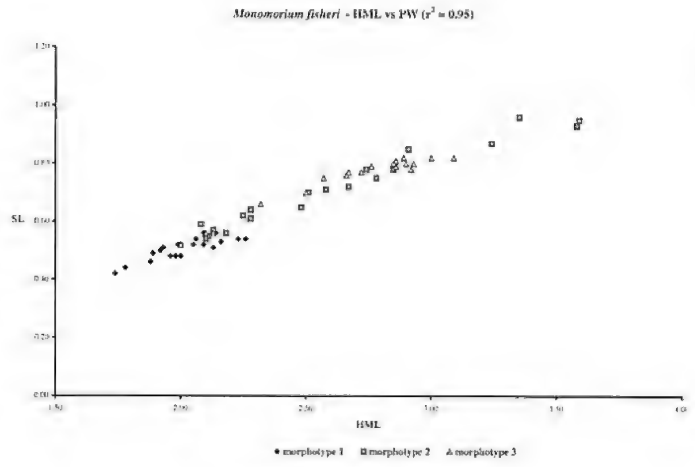

FIGURE 31. Scattegram showing relationship between head-mesosoma length (HML) and scape length (SL) for different morphotypes of *M. fisheri* sp. nov.

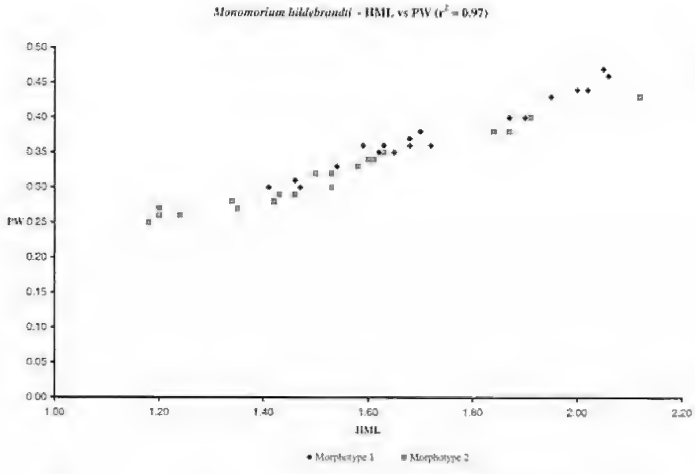

FIGURE 33. Scattegram showing relationship between head-mesosoma length (HML) and scape length (SL) for different morphotypes of *M. hildebrandti* sp. nov.

FIGURE 32. Distribution of *M. hildebrandti* (■) specimens examined during this study.

FIGURE 34. Distribution of *M. sechellense* (□) and *M. modestum* (■) specimens examined during this study.

PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES

Series 4, Volume 59, No. 19, pp. 723–729, 4 figs. December 30, 2008

Pseudiris speciosa, a New Genus and Species of Trimezieae (Iridoideae, Iridaceae) from Chapada Diamantina, Brazil

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***Pseudiris speciosa*, a new genus and species of Trimezieae (Iridoideae, Iridaceae) are here described based on morphological studies. Up to now, *Pseudiris speciosa* is only known from the "campos rupestres" (savanna with rocky outcrops) of the Chapada Diamantina, Bahia, Brazil. It is characterized by a compact erect corm-like rhizome wrapped by persistent fibrous tunic-like leaf bases, flowering stems cylindrical to elliptical in cross-section, with 3–4 bracts separated by long internodes, very showy flowers, lilac to blue, with inner and outer tepals unequal, and principally, style branches with two lilac to blue petaloid crests. Description, diagnosis, types, geographical distribution, illustrations, comparisons with closely related genera and an identification key to the genera that compose tribe Trimezieae are presented.**

Resumo

***Pseudiris speciosa*, novo gênero e espécie de Trimezieae (Iridoideae, Iridaceae) é aqui descrito baseado em estudos morfológicos. Provavelmente, *Pseudiris speciosa* é endêmica dos campos rupestres da Chapada Diamantina, Bahia, Brasil e caracteriza-se por apresentar rizomas eretos e compactos, semelhantes a cormos, envoltos por bases foliares persistentes fibrosas semelhantes a túnicas, escapos cilíndricos a elípticos em secção transversal, 3–4 brácteas separadas ao longo do escapo por longos entrenós, flores de lilás a azuis, vistosas, tépalas externas e internas distintas entre si e, principalmente, ramos do estilete com duas cristas petalóides lilases a azuis. São aqui apresentadas descrição, diagnose, tipos, distribuição geográfica, ilustrações, comparações com gêneros próximos de *Pseudiris* e uma chave de identificação dos gêneros que compõem Trimezieae.**

Iridaceae Juss. are among the largest families of the order Asparagales, comprising about 65–75 genera and 2030 species, cosmopolitan in distribution (Goldblatt et al. 2008). The family has its greatest diversity and species richness in southern Africa, and more than half of the species belong to only seven genera: *Iris* L. (ca. 275), *Gladiolus* L. (ca. 262), *Moraea* Mill. (ca. 200), *Sisyrinchium* L. (ca. 140), *Romulea* Maratti (ca. 95), *Babiana* Ker Gawl. ex Sims (ca. 90), *Geissorhiza* Ker Gawl. (86) (Goldblatt et al. 1998, Goldblatt et al. 2008). In Brazil occur about 14 genera

and 60 species (Takeuchi et al. 2008). Iridaceae is now divided into seven subfamilies, two of them, Iridoideae Pax and Crocoideae G. T. Burnett, are subdivided in five tribes (Goldblatt et al. 2008).

Trimezieae Ravenna belongs to Iridoideae and the name was proposed by Ravenna (1981) to substitute for Mariceae Hutch. (Hutchinson 1959), which was based on the illegitimate generic name *Marica* Schreb., a homotypic synonym of *Cipura* Aubl. (Sprague 1928). Hutchinson (1959) characterized Mariceae based on floral features: by having style branches deeply divided, but never winged or petaloid (these characters would exclude *Pseudiris* of Trimezieae). When Ravenna (1981) corrected the tribal name, he also emphasized different diagnostic characters, characterizing Trimezieae based on stem and leaf features: by the presence of a creeping or erect rhizome without tunic-like persistent leaf bases or a compact erect corm-like rhizome wrapped by persistent fibrous tunic-like leaf bases and linear, linear-ensiform, ensiform or cylindrical leaves (these characters would include *Pseudiris* in Trimezieae). Trimezieae included up to now three genera: *Neomarica* Sprague, *Trimezia* Salisb. ex Herb., and *Pseudotrimezia* Foster (Goldblatt et al. 2008, Chukr and Giulietti 2008). Molecular data indicate that Trimezieae, without *Pseudiris*, was retrieved as a strongly supported monophyletic group (Souza-Chies et al. 1997, Reeves et al. 2001, Goldblatt et al. 2008). The largest genus of Trimezieae is *Neomarica* with ca. 34 species (Gil et al. in prep.) which has a creeping or erect rhizome without persistent fibrous tunic-like leaf bases; flowering stems branched or simple, always flattened, always with a leaf-like bract at the first branch node and similar to the leaves, which are plane, ensiform and equitant; the flowers are showy with white, yellow and blue tepals, the internal tepals differ from the external ones by coloration, form and size; the styles have a cylindrical base and a tripartite apex, each style branch being divided into three filiform, ensiform, falcate or cuspidate crests, that are never petaloid, with a transversal stigmatic zone at the base of the crests; the fruit is a loculicidal capsule, erect or pending, with complete longitudinal dehiscence, often explosive, or opening only partially at the apex (Gil et al., in prep.). *Trimezia* with 18 species (Chukr and Giulietti 2008) shows the greatest morphologic diversity in the tribe, presenting a compact erect corm-like rhizome wrapped by persistent fibrous tunic-like leaf bases; leaves plane or cylindrical, flat or plicate; flowering stems branched or simple, generally cylindrical, without bracts or with one to many bracts; flowers yellow or blue, the internal tepals different from the external ones; styles as in *Neomarica* with the presence of a transversal stigmatic zone at the base of the crests or lobes, however each style branch can be divided into two (rarely three) crests or lobes; fruit a loculicidal capsule, erect, opening partially starting from the apex (Chukr and Giulietti 2008; Gil et al., in prep.). *Pseudotrimezia* presents a rootstock similar to *Trimezia* and is characterized by presenting cylindrical leaves (flat leaves only in *P. planifolia* Ravenna [Chukr and Giulietti 2003]); flowering stems branched or simple, cylindrical without bracts or more frequently possessing two imbricate bracts; flowers yellow, with subequal tepals; styles cylindrical, shortly tripartite at the apex, style branches without crests or lobes and with an apical stigmatic zone; fruit a loculicidal capsule, erect, opening partially or completely, starting from the apex (Chukr and Giulietti 2003).

During the preparation of the taxonomic generic revisions of Trimezieae (Chukr and Giulietti 2003; Chukr and Giulietti 2008; Gil et al. in prep.), a quite peculiar Iridaceae, originated from Chapada Diamantina (Bahia state, Brazil), was found in the collections of the consulted herbaria. At a first glance, the specimen seemed to be a species of *Iris* L. (tribe Irideae B.M. Kittel). A notable distinction among the Old and New World tribes of Iridoideae, however, is the position of the nectar guides on the tepals. In Irideae (Old World) the nectar guides are disposed on the outer tepals, while in the Neotropical (New World) tribes such guides are disposed on the inner tepals (Goldblatt 1990). Together, the nectar guides disposed on the inner tepals, the compact erect corm-like rhizome wrapped by persistent fibrous tunic-like leaf bases and the ensiform leaves justify the

inclusion of the new plant in the Neotropical tribe Trimezieae. However, various other characters observed in the collected specimen do not allow its inclusion in any of the three known genera of Trimezieae. A molecular phylogenetic analysis also indicates the distinctiveness. Therefore, a new genus and species are being proposed, based on morphologic studies, on cultivated plants and material deposited in the main national and international herbaria.

Genus and Species Description

Pseudiris speciosa **Chukr and A. Gil, gen. et sp. nov.**
Figure 1

Type.— Brazil. **Bahia**: Mucugê, projeto Sempre Viva. Campo rupestre. 26 Feb. 2001, *A.A. Ribeiro-Filho* 214 (holotype: HUEFS! isotype: UEC!).

Herbae perennes. Rhizoma 2.5–4 × 2.5–4 cm, globosa ad teretia compacta erecta cormiforma, foliis basibus persistentibus brunneis, fibrosis, glutinosis et tuniciformibus circumdati. Folia 33–129 × 0.7–2 cm, plana, lineari-ensiformia ad ensiformia, equitantia, unifacialia, subcoriacea, pallide viridia, nervibus parallelis prominentibus. Caules floriferi 49–146 × 0.4–1 cm, simplices vel 2–3-ramosi, erecti, recti ad sinuosi, teretes ad elliptici. Bracteae 3–4, 6.5–44 × 0.4–1.6 cm, foliiformes, separatae per 3–4 internodiis 7–40 cm longis. Rami floriferi 7.5–33 × 0.2–0.4 cm, recti ad sinuosi, teretes vel elliptici, desinentes in duo rhipidia spatharum coriacea ut includentes rhipidium. Rhipidia spatharum 6–9 × 0.4–0.8 cm, ovales ad oblongae, equitantes, imbricatae, apicibus acuminatis. Flores lilacini ad caerulei, fugaces, quoque flos subtentus per submembranaceae, ovales ad oblongae, bracteae. Tepala libera, disparia, unguiculata, ungue adscendente; limbi patentes vel reflexi, distales; tepala externa 3.5–6 × 1–2.4 cm, obovata vel oblonga, ungue vittis longitudinalibus pallide purpureis et trichomatibus capitatis, limbo apice emarginato; tepala interna 3–3.5 × 0.8–1 cm, obovata vel elliptica, ungue vittis longitudinalibus pallide purpureis, limbo vitta lutea inter duas fascias albas et numerosas pallide purpureas, trichomatibus capitatis, solum ad regionem medianam limbi unguiculati, apice acuminato. Filamenta 1.2–2 cm longa, alba, filiformia. Antherae 1–1.3 cm longae, caeruleae, stylis adpressis. Styli 3.2–3.7 cm longi, basi tereti, triangulares ad apicem, in tribus ramis libris terminati. Ramis stylis duabus petaloideis cristis et zona stigmatica transversali ad basin cristam. Cristae petaloideae 1–1.2 cm longae, lilacinae vel caeruleae, erectae. Capsulae 2.5–4 × 1–1.5 cm virides, obovatae vel oblongae, teretes ad trigonas, erectae, parte apicali dehiscentes, apice truncato. 2n=30.

Perennial herbs. Rhizome 2.5–4 × 2.5–4 cm, corm-like, compact, erect, globose to cylindrical, wrapped by persistent brown fibrous glutinous tunic-like leaf bases. Leaves 33–129 × 0.7–2 cm, plane, linear-ensiform to ensiform, equitant, unifacial, subcoriaceous, light green, with prominent parallel nerves on both sides. Flowering stems 49–146 × 0.4–1 cm, simple or 2–3-branched, erect, straight to sinuous, cylindrical to elliptical in cross-section, with 3–4 leaf-like bracts along the stem, 6.5–44 × 0.4–1.6 cm, separated by 3–4 internodes, 7–40 cm long. Flowering branches 7.5–33 × 0.2–0.4 cm, erect, straight to sinuous, cylindrical to elliptical in cross-section, ending in two leathery rhipidial spathes that enclose the rhipidia. Rhipidial spathes 6–9 × 0.4–0.8 cm, oval to oblong, imbricate, equitant, apices acuminate. Flowers showy, lilac to blue, fugacious (Fig. 2), each flower subtended by a submembranaceous, oval to oblong bract. Tepals free, unequal, clawed, claw ascending, limb spreading or reflexed distally; outer tepals 3.5–6 × 1–2.4 cm, obovate to oblong, claw with longitudinal light purple stripes and capitate trichomes, limb with emarginated apex; inner tepals 3–3.5 × 0.8–1 cm, obovate to elliptic, claw with longitudinal light purple stripes, limb

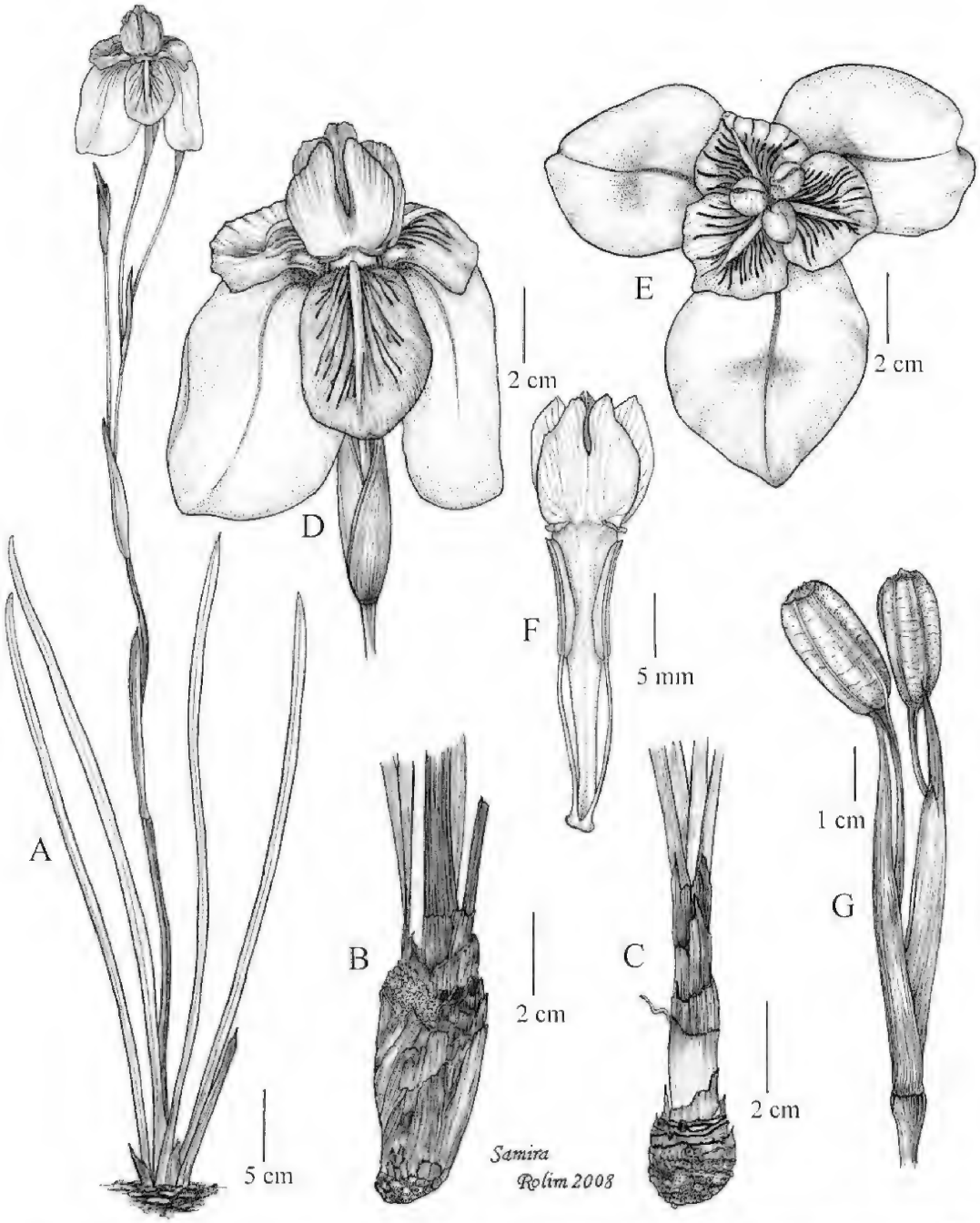

FIGURE 1. *Pseudiris speciosa* Chukr and Gil. A. habit; B. Underground system showing leaf bases wrapping the rhizome; C. Rhizome with leaf bases removed; D. flower in lateral view; E. flower seen from above; F. Style column showing style branches with petaloids crests and adpressed stamens; G. Rhipidial sphates with two erect immature capsules. (A-G from *D. Cardoso & A.A. Conceição* 434 [HUEFS])

with a yellow stripe between two white stripes and many light purple stripes, capitate trichomes present on the claw-limb medium region only, with acuminate apex. Filaments 1.2–2 cm long, white, filiform. Anthers 1–1.3 cm long, blue, adpressed to the style. Styles 3.2–3.7 cm long, cylindrical at base, turning triangular at the apex, divided into 3 free branches. Style branches with 2 petaloids crests and a transversal stigmatic zone at the base of the crests. Petaloid crests 1–1.2 cm long, lilac to blue, erect. Capsules 2.5–4 × 1–1.5 cm, green, obovoid to oblong, cylindrical to trigonous, erect, with partial apical dehiscence, apex truncated. 2n=30.

FIGURE 2. *Pseudiris speciosa* Chukr and Gil. Flower in lateral view, with a Chrysomelidae beetle on its inner tepal. (Photo by Abel Conceição.)

PARATYPES.— BRAZIL. **Bahia**: Lençóis, Serra da Chapadinha, Chapadinha, 12°275S, 41°2648W, 21 Feb. 1995, *E. Melo, M. Sena & F. França* 1660 (ALCB!, K!, SPF!); Mucugê, ca. 10 Km N. of Mucugê, on the road to Andaraí, rocky plateau with horizontally bedded rocks, and shallow peaty soil in crevices, with wet flushes, 12°56S, 41°20W, 08 Feb. 1974, *R.M. Harley, S.A. Renvoize, C.M. Erskine, C.A. Brighton & R. Pinheiro 16121* (K!); *Idem,* Parque das Sempre Vivas, 07 Jan. 2007, *N.S. Chukr* 799 (HUEFS!); *Idem*, Guiné, 31 Jan. 2000, *A. A. Conceição* 769 (SPF!); *Idem*, Gerais de Gobira, 13°0S, 41°23W, 19 Sep. 2002, *E.C. Smith* 257 (HUEFS!); *Idem*, Gobira, 13°0438S, 41°2231W, 04 Ago. 2004, *E.L. Borba, A.C.S. Pereira, P.L. Ribeiro & O.A. Oliveira* 1841 (HUEFS!); *Idem*, Parque Nacional da Chapada Diamantina, Serra do Esbarrancado, 12°4351S, 41°3033W, 16 Apr. 2005, *D. Cardoso & A. A. Conceição* 434 (HUEFS!); Road from Palmeiras to Capão, Km 12–15, 17 May 1992, *R.J.V. Alves, J. Becker & O. Roppa* 4201 (RB!).

FIGURE 3. *Pseudiris speciosa* Chukr and Gil. Plant in its natural habitat (savanna with rocky outcrops). (Photo by Abel Conceição.)

PHENOLOGY.— Collected with flowers and fruits from January to September.

DISTRIBUTION.— Known only from the Chapada Diamantina on "campos rupestres" (savanna with rocky outcrops [Fig. 3]), in the municipalities of Lençóis, Mucugê and on the road from Palmeiras to Capão, Bahia state, Brazil.

ETYMOLOGY.— The generic name is based on the combination of the Greek word *pseudo* (a combination of the Greek words: *pseudes* "false," or *pseudos* "falsehood," both from *pseudein* "to deceive") and the generic name *Iris*, with the intention of demonstrating the apparent similarity in flower morphology between *Pseudiris* and *Iris*. The epithet for this species is Latin for "showy, splendid", in reference to its splendid flowers.

We are unable to place *Pseudiris speciosa* in any known genus of Trimezieae. From *Neomar-*

ica, this new genus mainly differs in having a compact erect corm-like rhizome wrapped by persistent fibrous tunic-like leaf bases; flowering stems cylindrical to elliptical in cross-section; 3–4 bracts separated by long internodes along the flowering stem; stigmatiferous branches with 2 broad petaloids crests. From *Trimezia*, *Pseudiris speciosa* mainly differs in having stigmatiferous branches with broad petaloids crests. From *Pseudotrimezia*, the new genus mainly differs in having plane leaves, linear-ensiform to ensiform and 3–4 bracts separated by long internodes along the flowering stem; flowers lilac to blue; inner and outer tepals unequal; stigmatiferous branches with 2 broad petaloid crests. It is noteworthy that the tepal ornamentation of *Pseudiris* is quite singular, in having longitudinal linear stripes (similar as in *Iris sibirica* L.) differing from the other genera of Trimezieae, which have punctated, deformed or speckled spots and transversal linear stripes as tepal ornamentation.

A preliminary phylogenetic study of the Trimezieae based on chloroplast DNA sequences (trnH-psbA and trnG; Gil et al., in prep, see Fig. 4) helped us to reject the possibility of including *Pseudiris speciosa* in one of the three genera of this tribe. Using parsimony as well Bayesian methods, all clades within the tribe were well supported with the exclusion of *Pseudiris speciosa*. The conspicuous petaloid *Iris*-like style crests and the characters mentioned above justify the recognition of a new genus for the tribe.

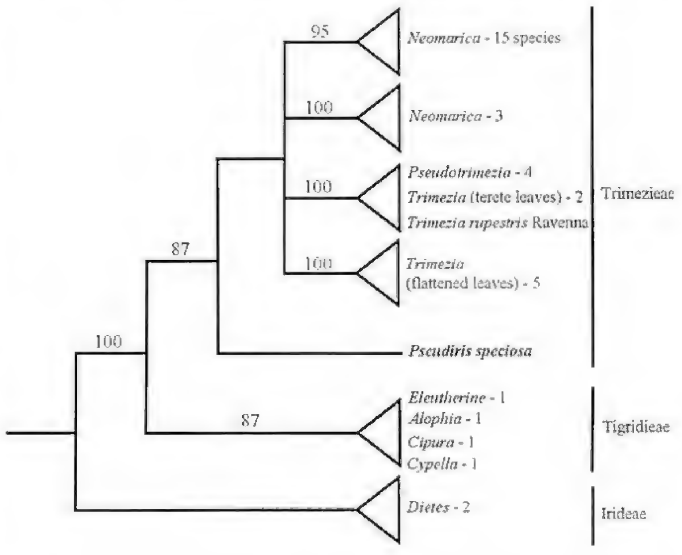

FIGURE 4. The majority-rule phylogenetic tree based on chloroplast DNA sequences (trnH-psbA and trnG) of the tribe Trimezieae, shown the major groups. Bayesian posterior probabilities (> 85%) are shown above the branches.

Key to the Genera of Trimezieae

1a. Creeping or erect rhizome without persistent fibrous tunic-like leaf bases; flowering stems always flattened, leaf-like ..... ***Neomarica***

1b. Compact erect corm-like rhizome wrapped by persistent fibrous tunic-like leaf bases; flowering stems generally cylindrical to elliptical in cross-section 2

2a. Inner and outer tepals subequal; style branches without crests or lobes, stigmatic zone apical. ..... ***Pseudotrimezia***

2b. Inner and outer tepals unequal, style branches with 2 or 3 crests or lobes, with a transversal stigmatic zone at the base of the stigmatic crests or lobes. 3

3a. Each style branch with two petaloid crests; tepals with longitudinal linear stripes. . ***Pseudiris***

3b. Each style branch divided into two (rarely three) more or less cuspidate crests or lobes, that are never petaloid; tepals with deformed, punctated or speckled spots. ..... ***Trimezia***

Acknowledgments

We thank Abel Conceição, Domingos Cardoso (Universidade Estadual de Feira de Santana, Bahia, Brazil) and Euvaldo Rodrigues (Parque Sempre-Vivas, Mucugê) for collecting and taking photos of *Pseudiris in situ*, and for sending us some rhizomes for cultivation; to Jorge Fontella Pereira (Universidade Federal do Rio de Janeiro/Museu Nacional, Rio de Janeiro, Brazil) for the insightful Latin description review; to José Eduardo Meireles (Duke University, North Carolina, USA) for helping with the phylogenetic analysis; to Juan Urdampilleta (Universidade Estadual de Campinas - UNICAMP, São Paulo, Brazil) for helping with the chromosome counts; to Volker Bittrich (UNICAMP) for the English review; to Samira Rolim for the illustrations; to Anete Pereira de Souza (UNICAMP) and Eliana Regina Forni Martins (UNICAMP) for the laboratorial support; to the curators of consulted herbaria for the loaned material; to the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) for research grants to ASBG, AMG and MCEA; and to an anonymous reviewer for the helpful comments and suggestions.

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PROCEEDINGS OF THE CALIFORNIA ACADEMY OF SCIENCES

Series 4, Volume 59, No. 20, p. 731. December 30, 2008

NOTICE OF RETRACTION AND CORRIGENDUM

A communication was received from Dr. James Parham relating to authorship of a paper published in the *Proceedings of the California Academy of Sciences*, series 4, vol. 57 (28 December 2006), pages 955–964, titled **Genetic evidence for premature taxonomic inflation in Middle Eastern tortoises**. Dr. Parham requests the following notice be issued:

Corrigendum

Dr. Yehudah Werner was mistakenly added as an author onto the paper **Genetic evidence for premature taxonomic inflation in Middle Eastern tortoises** because of a misunderstanding among the senior author (Parham), the organizing author (Papenfuss), and Dr. Werner. Dr. Werner had provided access to seminal materials that had been requested by Parham and Papenfuss but, through an oversight, he was not given an opportunity to review and critique the paper before submission for publication. Because of the oversight, Parham and Papenfuss want to correct the record and apologize to both Dr. Werner and the Editors of the Academy's *Proceedings*.

The Editor of the *Proceedings*, having received this notice, hereby retracts the paper as originally presented in the *Proceedings* and issues the following emendation to the title and authorship of the paper:

Genetic Evidence for Premature Taxonomic Inflation in Middle Eastern Tortoises

James F. Parham[1,2,9], Oguz Türkozan[3], Bryan L. Stuart[4,5], Marine Arakelyan[6], Soheila Shafei[7], J. Robert Macey[8], and Theodore J. Papenfuss[8]

[1] *Museum of Paleontology, 1101 Valley Life Sciences Building, University of California, Berkeley, CA 94720 USA; Email: Jparham@calacademy.org;* [2] *Evolutionary Genomics Department, Joint Genome Institute, 2800 Mitchell Drive, Walnut Creek, CA 94598 USA;* [3] *Adnan Menderes University, Faculty of Science and Arts, Department of Biology, Aydin, 09010 Turkey;* [4] *The Field Museum, Department of Zoology, Division of Amphibians & Reptiles, 1400 South Lake Shore Drive, Chicago, IL 60605 USA;* [5] *University of Illinois at Chicago, Department of Biological Sciences, 845 West Taylor, Chicago, IL 60607 USA;* [6] *Yerevan State University, Alek Manukyan 1, Yerevan 375025, Armenia;* [7] *Department of Biology, Faculty of Science, Shahid Bahonar University, 22 Bahman Blvd., Kerman, 79169-133 Iran;* [8] *Museum of Vertebrate Zoology, University of California, Berkeley, CA 94720 USA.*

Proceedings of the California Academy of Sciences, 2006,
ser. 4, 57(28 December)(33):955-964, figs. 1-2, 1 table, Appendix.

Index to Volume 59

Articles 1–20 and Supplement I

Compiled by Alan E. Leviton, Hallie Brignall and Michele L. Aldrich

(New taxa are in **boldface** type)

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